

# Chapter 7

## Science and Technology: Public Attitudes and Understanding

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## Highlights

### Information Sources, Interest, and Involvement

**Television and the Internet are the primary sources Americans use for science and technology (S&T) information. The Internet is the main source of information for learning about specific scientific issues such as global climate change or biotechnology.**

- ◆ More Americans select television as their primary source of S&T information than any other medium.
- ◆ The Internet ranks second among sources of S&T information, and its margin over other sources is large and has been growing.
- ◆ Internet users do not always assume that online S&T information is accurate. About four out of five have checked on the reliability of information at least once.

**Continuing a long-standing pattern, Americans consistently express high levels of interest in S&T in surveys. However, other indicators, such as the types of news they follow closely, suggest a lower level of interest.**

- ◆ High levels of interest in S&T are part of a long-standing trend, with more than 80% of Americans reporting they were “very” or “moderately” interested in new scientific discoveries. But relative to other news topics, interest in S&T is not particularly high.
- ◆ As with many news topics, the percentage of Americans who say they follow “science and technology” news “closely” has declined over the last 10 years.
- ◆ Recent surveys in other countries, including South Korea, China, and much of Europe, indicate that the overall level of public interest in “new scientific discoveries” and “use of new inventions and technologies” tends to be higher in the United States.
- ◆ Interest in “environmental pollution” or “the environment” is similarly high in the U.S., Europe, South Korea, and Brazil. About 9 in 10 respondents in each country expressed interest in this topic.

**In 2008, a majority of Americans said they had visited an informal science institution such as a zoo or a natural history museum within the past year. This proportion is generally consistent with results from surveys conducted since 1979, but slightly lower than the proportion recorded in 2001.**

- ◆ Americans with more formal education are much more likely to engage in informal science activities.
- ◆ Compared with the United States, visits to informal science institutions tend to be less common in Europe, Japan, China, Russia, and Brazil.

### Public Knowledge About S&T

**Many Americans do not give correct answers to questions about basic factual knowledge of science or the scientific inquiry process.**

- ◆ Americans’ factual knowledge about science is positively related to their formal education level, income level, the number of science and math courses they have taken, and their verbal ability.
- ◆ People who score well on long-standing knowledge measures that test for information typically learned in school also appear to know more about new science related topics such as nanotechnology.

**Levels of factual knowledge of science in the United States are comparable to those in Europe and appear to be higher than in Japan, China, or Russia.**

- ◆ In the United States, levels of factual knowledge of science have been stable; Europe shows evidence of recent improvement in factual knowledge of science.
- ◆ In European countries, China, and Korea demographic variations in factual knowledge are similar to those in the United States.

**Compared to the mid-1990s, Americans show a modest improvement in understanding the process of scientific inquiry in recent years.**

- ◆ Americans’ understanding of scientific inquiry is strongly associated with their factual knowledge of science and level of education.
- ◆ Americans’ scores on questions measuring their understanding of the logic of experimentation and controlling variables do not differ by sex. In contrast, men tend to score higher than women on factual knowledge questions in the physical sciences.

### Public Attitudes About S&T in General

**Americans in all demographic groups consistently endorse the past achievements and future promise of S&T.**

- ◆ In 2008, 68% of Americans said that the benefits of scientific research have strongly outweighed the harmful results, and only 10% said harmful results slightly or strongly outweighed the benefits.
- ◆ Nearly 9 in 10 Americans agree with the statement “because of science and technology, there will be more opportunities for the next generation.”
- ◆ Americans also express some reservations about science. Nearly half of Americans agree that “science makes our way of life change too fast.”

- ◆ Americans tend to have more favorable attitudes about the promise of S&T than Europeans, Russians, and the Japanese. Attitudes about the promise of S&T in China and South Korea are as positive as those in the United States and in some instances even more favorable. However, residents of China and Korea are more likely than Americans to think that “science makes our way of life change too fast.”

**Support for government funding of scientific research is strong.**

- ◆ In 2008, 84% of Americans expressed support for government funding of basic research.
- ◆ More than one-third of Americans (38%) said in 2008 that the government spends too little on scientific research and 11% said the government spends too much. Other kinds of federal spending such as health care and education generate stronger public support.

**The public expresses confidence in science leaders.**

- ◆ In 2008, more Americans expressed a “great deal” of confidence in scientific leaders than in the leaders of any other institution except the military.
- ◆ Despite a general decline in confidence in institutional leaders that has spanned more than three decades, confidence in science leaders has remained relatively stable. The proportion of Americans indicating “a great deal of confidence” in the scientific community oscillated between 35% and 45% in surveys conducted since 1973. In every survey, the scientific community has ranked either second or third among institutional leaders.
- ◆ On science-related public policy issues (including global climate change, stem cell research, and genetically modified foods), Americans believe that science leaders, compared with leaders in other sectors, are relatively knowledgeable and impartial and should be relatively influential. However, they also perceive a considerable lack of consensus among scientists on these issues.

**Over half of Americans (56%) accord scientists “very great prestige.” Ratings for engineers are lower (40% indicate “very great prestige”), but nonetheless better than those of most other occupations.**

- ◆ In 2008, scientists ranked higher in prestige than 23 other occupations surveyed, a ranking similar to that of firefighters.
- ◆ Between 2007 and 2008, engineers’ rating of “very high prestige” increased from 30% of survey respondents to 40%.

**Public Attitudes About Specific S&T Issues**

**Americans have recently become more concerned about environmental quality. However, concern about the environment is outranked by concern about the economy, unemployment, and the war in Iraq.**

- ◆ Between 2004 and 2008, the proportion of Americans expressing “a great deal” or “a fair amount” of worry about the quality of the environment increased from 62% to 74%. Nonetheless, when asked to name the country’s top problem in early 2009, only about 2% mentioned environmental issues.
- ◆ In 2008, 67% of Americans believed that the government was spending too little to reduce pollution and 7% thought it was spending too much.
- ◆ The trend in support for environmental protection is less evident when Americans are asked about trade-offs between environmental protection and economic growth. In March 2009, 51% of all Americans indicated that economic growth should take precedence over the environment.

**Americans support the development of alternative sources of energy.**

- ◆ A majority of Americans favor government spending to develop alternate sources of fuel for cars (86%), to develop solar and wind power (79%), and to enforce environmentally friendly regulations such as setting higher emissions and pollution standards for business and industry (84%).
- ◆ Since the mid-1990s, American public opinion on nuclear energy has been evenly divided, but the proportion of Americans favoring the use of nuclear power as one of the ways to provide electricity for the U.S. increased from 53% in 2007 to 59% in 2009.
- ◆ Europeans are divided on nuclear energy, but support is on the rise. The proportion of Europeans who said they favored energy production by nuclear power stations increased from 37% in 2005 to 44% in 2008, while the proportion opposing it decreased from 54% in 2005 to 45% in 2008. Support for nuclear energy varies a great deal among countries in this region. Citizens in countries that have operational nuclear power plants are more likely to support nuclear energy than those in other countries.

**Despite the increased funding of nanotechnology and growing numbers of nanotechnology products in the market, Americans remain largely unfamiliar with this technology.**

- ◆ Even among respondents who had heard of nanotechnology, knowledge levels were not high.
- ◆ When nanotechnology is defined in surveys, Americans express favorable attitudes overall.

**A majority of Americans favor medical research that uses stem cells from human embryos. However, Americans are overwhelmingly opposed to reproductive cloning and wary of innovations using “cloning technology.”**

♦ Support for embryonic stem cell research is similar to previous years. In 2008, 57% of Americans favored

embryonic stem cell research while 36% opposed it. A higher proportion (70%) favors stem cell research when it does not involve human embryos.

♦ More than three-quarters of Americans oppose human cloning.

## Introduction

### Chapter Overview

Science and technology (S&T) affect all aspects of American life. As workers, Americans use technology to improve productivity in ways that could not even be imagined a generation ago, applying recently invented tools and applications. As consumers, they entertain themselves with high technology electronic products; make friends, communicate, and keep informed about the world through the Internet; and benefit from advances in medical technologies. As citizens, they may engage in discussions on climate change, stem cell research, and deficit spending—issues about which atmospheric scientists, microbiologists, and macroeconomists have formal training and expertise.

It is increasingly difficult for Americans to be competent as workers, consumers, and citizens without some degree of competence in S&T. Because competence begins with understanding, this chapter presents indicators about news, information, and knowledge of S&T. How the American citizenry collectively deals with public issues that involve S&T may, in turn, affect what kinds of S&T development America will support. Thus the chapter includes indicators of people's attitudes about S&T-related issues. To put U.S. data in context, this chapter examines trend indicators for past years and comparative indicators for other countries.

### Chapter Organization

The chapter is divided into four major sections. The first section includes indicators of the public's sources of information about, level of interest in, and active involvement with S&T. The second section reports indicators of public knowledge, including measures of factual knowledge of science and engineering and people's understanding of the scientific process. When possible, it compares American adults' understanding of science to that of American students. The third and fourth sections of the chapter describe public attitudes toward S&T. The third section contains data on attitudes about S&T in general, including support for government funding of basic research, confidence in the leadership of the scientific community, perceptions of the prestige of S&E occupations, and opinions about how much influence science and scientists should have in public affairs. The fourth section addresses public attitudes on issues in which S&T plays an important role, such as the environment, the quality of science and math education, and the use of animals in scientific research. It also includes indicators of public opinion about several emerging lines of research and new technologies, including nuclear power, biotechnology, genetically modified (GM) food, nanotechnology, stem cell research, and cloning.

### A Note About the Data and the Terminology

This chapter emphasizes trends over time, patterns of variation within the U.S. population, and international patterns. It gives less weight to the specific percentages of survey respondents who gave particular answers to the questions posed to them. Although, inevitably, the chapter reports these percentages, they are subject to numerous sources of error and should be treated with caution. Caution is especially warranted for data from surveys that omit significant portions of the target population, have low response rates, or have topics that are particularly sensitive to subtle differences in question wording. In contrast to specific percentages, consistent and substantial trends and patterns warrant greater confidence (see sidebar, "Survey Data Sources").

Most of the international comparisons involve identical questions asked in different countries. However, language and cultural differences can affect how respondents interpret questions and can introduce numerous complexities, so international comparisons require careful consideration.

Throughout the chapter, the terminology used in the text reflects the wording in the corresponding survey question. In general, survey questions asking respondents about their primary sources of information, interest in issues in the news, and general attitudes use the phrase "science and technology." Thus the term "S&T" is used in the parts of the chapter discussing these data. Survey questions asking about confidence in institutional leaders, prestige of occupations, and views of different disciplines use terms such as "scientific community," "scientists," "researchers," or "engineers," so "S&E" is used in sections examining issues related to occupations, careers, and fields of research. Although science and engineering are distinct fields, national data that make this distinction are scarce.

### Information Sources, Interest, and Involvement

Because S&T are relevant to so many aspects of daily life, information about S&T can help Americans make informed decisions and more easily navigate the world around them. Interest in and involvement with S&T can lead Americans to acquire more information and achieve greater understanding.

### S&T Information Sources

#### U.S. Patterns and Trends

More Americans get most of their information about current news events from television than from any other source. When asked "Where do you get most of your information about current news events?," 47% say television, with substantial percentages also reporting the Internet (22%) and newspapers (20%) as their main source (figure 7-1; appendix table 7-1). Since the 1990s, the proportion of Americans getting information about current news events from the

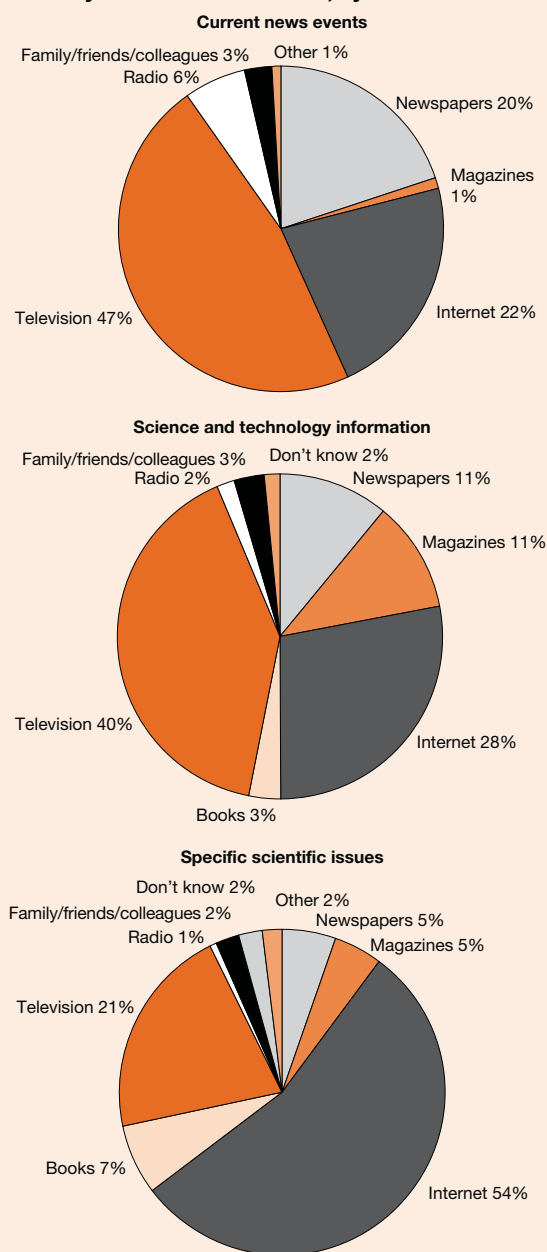
Survey Data Sources						
National scope	Sponsoring organization	Title	Years used	Information used	Data collection method	Number of respondents/ margin of error of general population estimates
United States	National Science Foundation (NSF)	Public Attitudes Toward and Understanding of Science and Technology (1979–2001); includes University of Michigan Survey of Consumer Attitudes 2004	1979–2001, 2004	Information sources, interest, informal science institution visits, government spending, general attitudes, science/math education and animal research attitudes	Random direct dialing (RDD) computer-assisted telephone survey	n = ~1,600–2,000 ± 2.47% – ± 3.03%
	National Opinion Research Center (NORC) at the University of Chicago	General Social Survey (GSS)	1973–2008	Government spending, confidence in institutional leaders	Face-to-face interviews	Government spending: n = 1,574–2,992 ± 2.1% – ± 3.5%  Confidence in institutional leaders: n = 876–1,989 ± 2.6% – ± 3.8%
	NORC at the University of Chicago	GSS S&T module	2006, 2008	Information sources, interest, informal science institution visits, government spending, general attitudes, science/math education and animal research attitudes, nanotechnology awareness and attitudes	Face-to-face interviews	n = 1,864 (2006) ± 2.68%  n = 1,505 (2008) ± 2.98%
	Gallup Organization	Various ongoing surveys	1984, 1990–1992, 1995, 1997–2009	Environment, stem cell research, nuclear power attitudes	RDD	n = ~1,000 ± 3.0%
	Virginia Commonwealth University (VCU) Center for Public Policy	VCU Life Sciences Survey	2001–08	S&T interest, general attitudes, stem cell research and animal research attitudes	RDD	n = ~1,000 ± 3.0% (2006 and 2007) ± 3.8% (2008)
	Department of Education, National Center for Education Statistics (NCES)	National Assessment of Education Progress (NAEP)	2000 (8 <sup>th</sup> graders); 2005 (4 <sup>th</sup> and 8 <sup>th</sup> graders)	Science knowledge	Paper questionnaires	2000 (independent national sample): n = 15,955 8 <sup>th</sup> graders ± 2.2% (one question used)  2005 (combined national/state sample): n = 147,700 4 <sup>th</sup> graders ± 1.0% (one question used)  n = 143,400 8 <sup>th</sup> graders ± 0.8% – 1.2% (three questions used)
	American Association for the Advancement of Science (AAAS)	AAAS Project 2061 (unpublished results, 2008)	2007 (middle school students)	Science knowledge	Paper questionnaires	n = 2,047 middle school students n = 1,597 (follow-up question)
	Pew Research Center for the People & the Press	Biennial News Consumption Survey	1996–2008	Information sources, interest	RDD	n = 3,615 (2008) ± 2.0%
	Pew Research Center for the People & the Press	News Interest Index	2007–2008	Information sources, interest	RDD	n = ~1,000 ± 3.5%
	Pew Internet & American Life Project	Pew Internet & American Life Project Survey	2006	Information sources, interest, involvement	RDD	n = 2,000 ± 3.0%
	Harris Interactive	The Harris Poll	1977–2008	Occupational prestige attitudes, internet use	RDD	Occupational prestige: n = ~1,000 (~500 asked about each occupation) Internet use n = ~2,020
	CBS News/New York Times	CBS News/New York Times Poll	2008	Genetically modified food awareness and attitudes	RDD	n = 1,065 ± 3.0%
	Woodrow Wilson International Center for Scholars	Project on Emerging Nanotechnologies (2008)	2008	Nanotechnology awareness and attitudes	Telephone interviews	n = 1,003 ± 3.1%

## Survey Data Sources

National scope	Sponsoring organization	Title	Years used	Information used	Data collection method	Number of respondents/ margin of error of general population estimates
International	European Commission	Special Eurobarometer 224/Wave 63.1: <i>Europeans, Science and Technology</i> (2005); Special Eurobarometer 282/Wave 67.2: <i>Scientific Research in the Media</i> (2007); Special Eurobarometer 297/Wave 69.1: <i>Attitudes Towards Radioactive Waste</i> (2008); Special Eurobarometer 300/Wave 69.2: <i>Europeans' Attitudes Towards Climate Change</i> (2008)	1992, 2005, 2007, 2008	Knowledge, trust in scientists and public support for basic research attitudes, among others	Face-to-face interviews	n = 32,897 total: ~1,000 for 27 countries, ~500 for 4 countries (2005) n = 26,717 total: ~1,000 for 24 countries, ~500 for 3 countries (2007) n = 26,746 total: ~1,000 for 24 countries, ~500 for 3 countries (2008) n=30,170 total: ~1,000 for 27 countries, ~500 for 4 countries (2008) ± 1.9% – ± 3.1%
	Canadian Biotechnology Secretariat	Canada-U.S. Survey on Biotechnology	2005	Biotechnology, nanotechnology, and other technology attitudes (includes U.S. data on specific issues)	RDD	Canada: n = 2,000 ± 2.19% U.S.: n = 1,200 ± 2.81%
	British Council, Russia	Russian Public Opinion of the Knowledge Economy (2004)	1996, 2003	Various knowledge and attitude items	Paper questionnaires	n = 2,107 (2003)
	Chinese Ministry of Science and Technology	<i>China Science and Technology Indicator 2002</i> (2002)	2001	Various knowledge and attitude items	Information not available	n = 8,350
	China Research Institute for Science Popularization (CRISP)	Chinese Public Understanding of Science and Attitudes towards Science and Technology, 2007 (2008)	2007	Various knowledge and attitude items	Face-to-face interviews	n = 10,059 (2007) ± 3.0%
	Japan National Institute of Science and Technology Policy	The 2001 Survey of Public Attitudes Toward and Understanding of Science & Technology in Japan	2001	Various knowledge and attitude items	Face-to-face interviews	n=2,146
	Korea Foundation for the Advancement of Science and Creativity (KOFAC, formerly Korea Science Foundation)	Survey of Public Attitudes Toward and Understanding of Science and Tech-nology 2004, 2008	2004, 2006, 2008	Interest, informal science institution visits, various knowledge and attitude items	Face-to-face interviews	n = 1,000 ± 3.1%
	Malaysian Science and Technology Information Centre	<i>Public Awareness of Science and Technology Malaysia 2004</i> (2005)	2004	Various knowledge and attitude items	Face-to-face interviews	n = 6,896 ± 2.0%
	India National Council of Applied Economic Research	India Science Survey 2004	2004	Various knowledge and attitude items	Face-to-face interviews	n = 30,255
	Department of Education, NCES	Trends in International Mathematics and Science Study (TIMSS)	2003 (8 <sup>th</sup> grade)	Science knowledge	Paper questionnaires	U.S.: n = 8,912 ± 1.4% (for all TIMSS questions)  Other 44 countries: n = 2,943–8,952± 1.0% – 2.4% (for all TIMSS questions)
	BBVA Foundation	BBVA Foundation International Study on Attitudes Towards Stem Cell Research and Hybrid Embryos (2008)	2007/2008 combined	Knowledge, awareness, and attitudes on stem cell research	Face-to-face interviews	n = 1,500 in each of 15 countries ± 2.6%
	Ministry of Science and Technology of Brazil	<i>Public Perceptions of Science and Technology</i> (2007)	2006	Interest, informal science institution visits	Face-to-face interviews	n = 2,004 ± 2.2%
	Samuel Neaman Institute for Advanced Studies in Science and Technology	<i>Science and Technology in the Israeli Consciousness</i> (2006)	2006	Prestige of science careers	Telephone interviews	n = 490

NOTES: All surveys are national in scope. Statistics on number of respondents and margin of error are as reported by the sponsoring organization. When a margin of error was not cited, none was given by the sponsor.

Figure 7-1  
Primary source of information, by use: 2008



NOTES: Government agencies included in "other" category because <1.0% response. For current news events, books also included in "other" category and "don't know" not shown because <1.0% response. For science and technology information, "other" category not shown because <1.0% and no government agency responses. Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix tables 7-1, 7-2, and 7-3.

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Internet has increased considerably and the proportion using newspapers for current events has declined (figure 7-2).<sup>1</sup> However, audiences are getting news from both traditional sources (television, print) and the Internet and blending these sources together, rather than choosing between one or another (Pew Research Center for the People and the Press 2008).

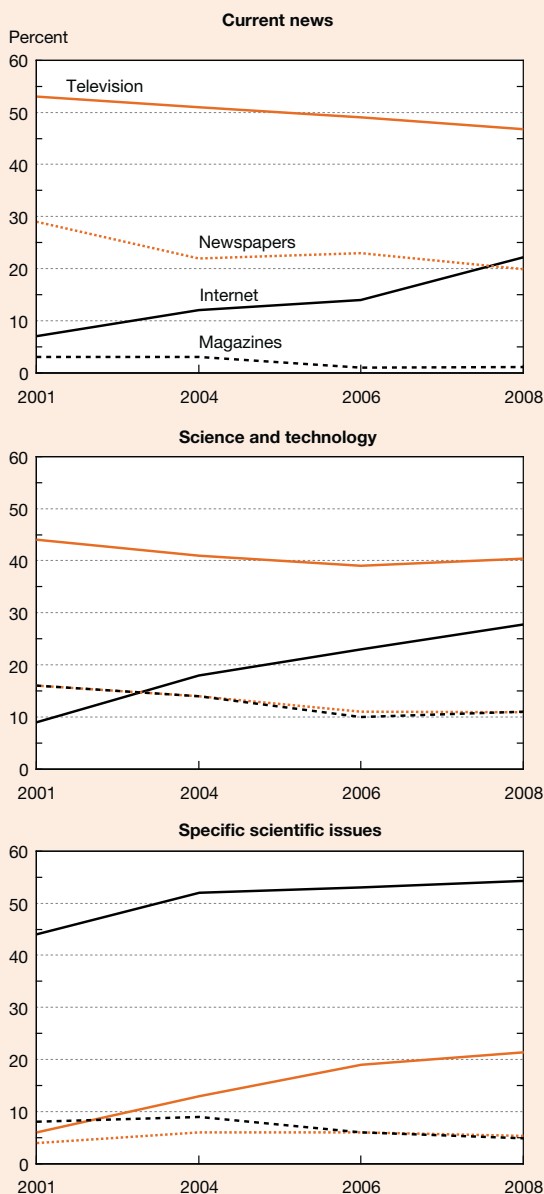
Americans report a somewhat different pattern of primary sources for S&T information than for information about current news events (figure 7-3; appendix tables 7-1 and 7-2). For both kinds of information, more Americans select television as their primary source than any other medium, followed by the Internet. The Internet, magazines, and books or other printed material are more widely used as primary information sources for S&T than for current news; the opposite is true for television, newspapers, and radio (figure 7-3). The proportion of Americans who said the Internet was their primary source for S&T news grew from 22% in 2006 to 28% in 2008. Since 2001, this proportion has more than tripled (figure 7-2).

When asked, "If you wanted to learn about scientific issues such as global warming or biotechnology, where would you get information?," 54% of Americans choose the Internet even though almost one out of five Americans cannot access the Internet at home, work, schools, libraries, and other locations (Harris Interactive 2008a). Television (21%) ranked as a distant second (figure 7-1; appendix table 7-3). Reliance on the Internet, which grew substantially over the past decade, is still growing but shows signs of leveling off (figure 7-2).

In general, use of the Internet for news and information, including S&T information, is higher among younger audiences and increases with education and income. (Access to high-speed Internet connections is also associated with more time online and more extensive reliance on the Internet for news and information [Cole 2007; Horrigan 2006].) Conversely, the use of television decreases with education and income and increases with age (appendix tables 7-1 and 7-2). Analyses that examine age differences in patterns of media use through repeated cross-sectional surveys hide considerable generational effects, because they only show a snapshot of a single point in time (Losh 2009). Younger generations that grow up relying more exclusively on the Internet are not likely to shift to traditional media as they age.

National data that address the processes through which Americans acquire and sort through S&T information are scarce. A Pew Internet and American Life Project survey (Horrigan 2006) examined how Americans use the Internet to acquire information about science. It found that a clear majority of Internet users had engaged in some information search activities, including "look[ing] up the meaning of a particular scientific term or concept" (70%), "look[ing] for an answer to a question you have about a scientific concept or theory" (68%), and "learn[ing] more about a science story or scientific discovery you first heard or read about offline" (65%). In addition, just over half had used the Internet to "complete a science assignment for school, either for

Figure 7-2  
**Primary source of information about current events, science and technology, and specific scientific issues: 2001–08**



SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (2001); University of Michigan, Survey of Consumer Attitudes (2004); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008). See appendix tables 7-1, 7-2, and 7-3.

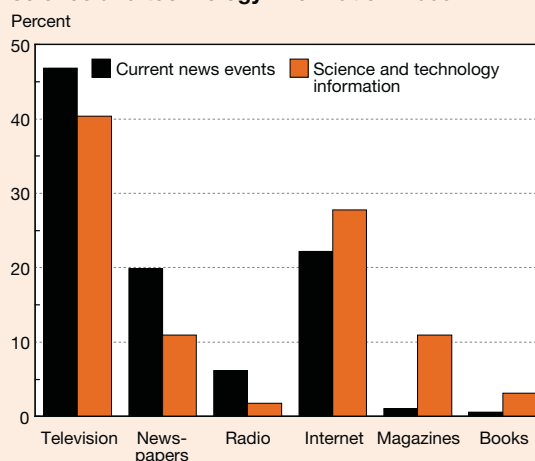
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yourself or for a child” (55%) or to “check the accuracy of a scientific fact or statistic” (52%). Fewer had used the Internet to “download scientific data, graphs, or charts” (43%) or “compare different or opposing scientific theories” (37%). How skillfully or how often Americans engage in the search for scientific information, whether on the Internet or elsewhere, remains unknown.

Using information effectively involves more than finding it. In an information-saturated society, people often need to assess the quality of the information they encounter and determine its credibility. Survey data provide some indication of how Americans assess the credibility of public information. For the past ten years, Americans have become more skeptical of the information they encounter in major broadcast and print media, but recently this trend has leveled off. Americans’ judgments of media credibility are shaped by factors other than critical thinking skills and the quality of the information provided. For example, judgments of the credibility of particular mass media information sources are associated with political party affiliations (Pew Research Center for the People and the Press 2008).

Evidence about how Americans judge the credibility of S&T information in the media is scant. Pew’s study of how Americans acquire science information indicates that Internet users who seek science information online do not always assume that the information they find there is accurate. The vast majority (80%) reported they have checked information at least once in different ways, either by comparing it to other information they found online, comparing it to offline sources (science journals, encyclopedia), or looking up the original source of the information (Horrihan 2006; for additional details see NSB 2008).

Figure 7-3  
**Primary source of current news events and science and technology information: 2008**



SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix tables 7-1 and 7-2.

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### International Comparisons

As in the United States, data collected between 2001 and 2008 in other countries, including the European Union (EU) states, Japan, Russia, and China, uniformly identify television as the leading source of S&T news and information. In a 2008 South Korean survey, more respondents named the Internet (28%) as their primary source of S&T information than named newspapers (16%) (KOFAC 2009). In most other countries, however, newspapers generally ranked second and relatively few survey respondents cited the Internet as an important source of S&T information. This may be due to differences in the availability of Internet access across countries (Internet World Statistics 2009). National differences in how questions were asked make precise comparisons among different countries impossible.

More recent data on S&T for the other countries do not exist; further details on these older data are presented in the 2006 edition of *Science and Engineering Indicators* (NSB 2006). Television is also the dominant source of S&T information in India, where about two-thirds of survey respondents in 2004 said it was their main information source (Shukla 2005). Radio (13%) and friends/relatives (12%) ranked ahead of print sources such as newspapers, books, and magazines, which together accounted for 9% of responses. India's relatively low literacy rate (144th of 176 countries in a 2005 ranking) may contribute to this reliance on nonprinted sources.

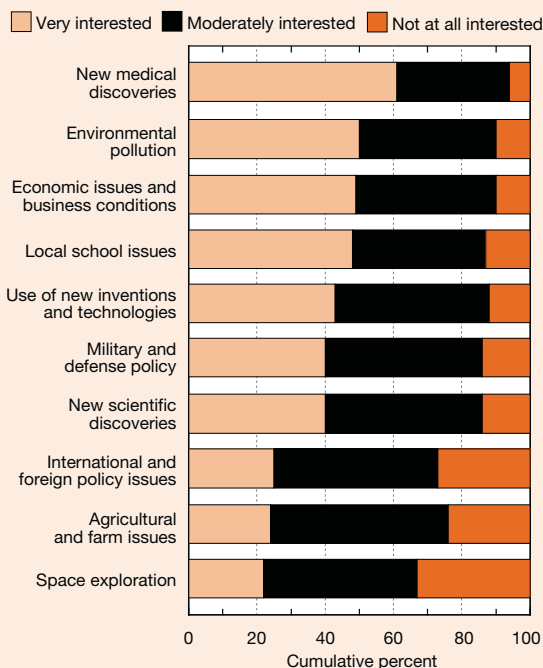
### Public Interest in S&T

#### U.S. Patterns and Trends

High levels of self-reported interest in S&T are part of a long-standing pattern, as shown in the results of 12 surveys funded by the National Science Foundation (NSF). More than 80% of Americans report they are interested in new scientific discoveries (figure 7-4). When asked in the General Social Survey (GSS) in 2008 about their interest in new scientific discoveries, 86% reported that they are either "very" or "moderately" interested (appendix table 7-4). The proportion of respondents expressing interest in new scientific discoveries decreased slightly between 2001 and 2008 (figure 7-5), but this decline might have resulted from a difference in the surveys' data collection over that period.<sup>2</sup> Comparable data from the Virginia Commonwealth University (VCU) show a stable trend in public interest in new scientific discoveries between 2001 and 2006—during this period the proportion of Americans who said they had "a lot" or "some" interest in new scientific discoveries fluctuated between 83% and 87% (VCU Center for Public Policy 2006; see NSB 2008). Interest in new scientific discoveries increases with education and the number of mathematics and science courses people have taken (appendix table 7-5).

Relative to interest in other topics, however, interest in S&T in the GSS was not particularly high (figure 7-4). Interest in "new scientific discoveries" and "use of new inventions and technologies" ranked in the middle among the 10 areas

Figure 7-4  
Public interest in selected issues: 2008

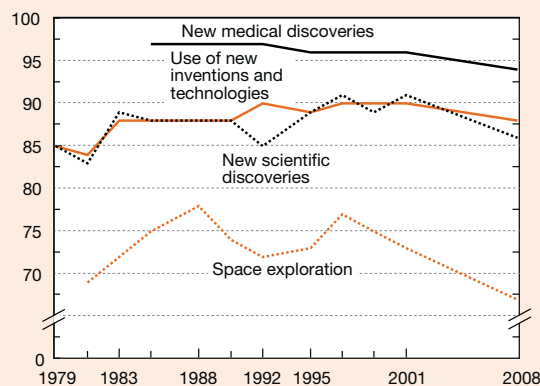


SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix table 7-4.

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Figure 7-5  
Public interest in selected science-related issues: 1979–2008

Percent very/moderately interested



NOTES: Table includes all years for which data collected; other years extrapolated.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1985–2001); and University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix table 7-4.

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most frequently listed in the surveys: above space exploration, agriculture and farming, and international and foreign policy; below new medical discoveries, environmental pollution, economic issues and business conditions, and about the same as military and defense policy and local schools. Of course, a more inclusive concept of S&T might treat several of the topics in this list, such as space exploration and new medical discoveries, as part of the S&T category; furthermore, other topics often include substantial S&T content.<sup>3</sup>

Survey responses about the types of news Americans follow raise questions about how interested Americans really are in S&T. For more than 10 years, Pew (Pew Research Center for the People and the Press 2008) has collected data on categories of news that Americans follow “very closely.” In 2008, 13% of the public followed S&T news closely. S&T news ranked 13th among 18 topics, tied with consumer news and ahead of entertainment, culture and the arts, celebrity news, and travel (table 7-1). As is the case for many other news topics, the percentage of Americans who say they follow S&T closely has declined between 1996 and 2008. S&T’s relative standing in the list of topics has also slipped; it ranked ahead of seven topics in 1996, but ahead of only two of the same topics in 2008.

Since 1986, the Pew Research Center for the People and the Press has maintained a news interest index that tracks individual stories that make headlines. The index is based

on frequent surveys that record the proportion of Americans who, when asked about a news story, say they are following it “very closely.” Stories that attract considerable public interest are often included in several surveys, and the same story may appear several times in the news interest index. In 2007, stories that dominated the list of the public’s top news stories included the rising price of gasoline, the war in Iraq, and human and natural disasters (such as the Virginia Tech University shootings, the Minneapolis bridge collapse, and the California wildfires) (PEJ 2008). In 2008, stories about the condition of the U.S. economy, rising gas prices, the debate over a Wall Street bailout, the 2008 presidential election, major drops in the U.S. stock market, and the impact of Hurricane Ike appeared near the top of the list (PEJ 2009). Interest in S&T does not appear to have been the central factor motivating the public’s interest in these stories rather than others.

A different kind of news indicator is the amount of coverage news organizations devote to S&T. This indicator can involve either sheer quantity (e.g., broadcast time) or prominence (e.g., lead stories). For 20 years, the Tyndall Report has tracked the time that the three major broadcast networks devoted to 18 categories of news on their nightly newscasts (Tyndall Report 2009). Two categories with large science, engineering, and technology components are “science, space, and technology,” and “biotechnology and basic

Table 7-1  
News followed “very closely” by American public: 1996–2008  
(Percent)

Type of news	1996	1998	2000	2002	2004	2006	2008
Weather .....	NA	NA	NA	NA	53	50	48
Crime .....	41	36	30	30	32	29	28
Education .....	NA	NA	NA	NA	NA	NA	23
Community .....	35	34	26	31	28	26	22
Environment .....	NA	NA	NA	NA	NA	NA	21
Politics/Washington news .....	16	19	17	21	24	17	21
Local government.....	24	23	20	22	22	20	20
Health news.....	34	34	29	26	26	24	20
Sports.....	26	27	27	25	25	23	20
Religion.....	17	18	21	19	20	16	17
International affairs.....	16	16	14	21	24	17	16
Business and finance .....	13	17	14	15	14	14	16
Consumer news .....	14	15	12	12	13	12	13
Science and technology.....	20	22	18	17	16	15	13
Culture and arts.....	9	12	10	9	10	9	11
Entertainment .....	15	16	15	14	15	12	10
Celebrity news.....	NA	NA	NA	NA	NA	NA	7
Travel .....	NA	NA	NA	NA	NA	NA	6

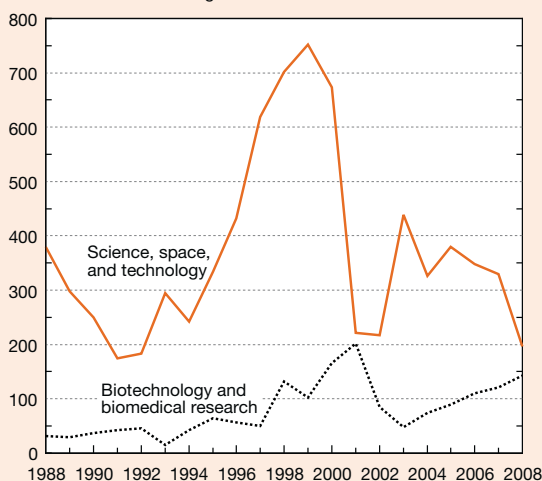
NA = not available, question not asked

NOTES: Data reflect respondents who said they followed type of news “very closely.” Table includes all years for which data collected.

SOURCES: Pew Research Center for the People and the Press, Online papers modestly boost newspaper readership: Maturing Internet news audience broader than deep (30 July 2006), Biennial News Consumption Survey (27 April–22 May 2006), <http://people-press.org/reports/display.php3?ReportID=282>, accessed 26 April 2007 (1996–2006); Pew Research Center for the People and the Press, Audience segments in a changing news environment: Key news audiences now blend online and traditional sources (17 August 2008), p. 39, Biennial News Consumption Survey (30 April–01 June 2008), <http://people-press.org/reports/pdf/444.pdf>, accessed 21 September 2009.

Figure 7-6  
**Network nightly news coverage of science and technology: 1988–2008**

Annual minutes of coverage



NOTES: Data reflect annual minutes of story coverage on topics by major networks ABC, CBS, and NBC, out of approximately 15,000 total annual minutes on weekday nightly newscasts. Excluded from science, space, and technology are forensic science and media content. Excluded from biotechnology and basic medical research are stories on clinical research and medical technology.

SOURCE: Tyndall Report, special tabulations (2009), <http://www.tyndallreport.com>, accessed 23 September 2009.

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medical research. “Science, space and technology” includes stories on manned and unmanned space flight, astronomy, scientific research, computers, the Internet, and telecommunications media technology. It excludes forensic science, and telecommunications media content. “Biotechnology and basic medical research” includes stem cell research, genetic research, cloning, and agribusiness bioengineering and excludes clinical research and medical technology. Stories often do not fall neatly into a single category or theme.

Neither category has ever occupied a large percentage of the approximately 15,000 minutes of annual nightly weekday newscast coverage on the networks. “Science, space, and technology,” the larger of the two categories, garnered 752 minutes in its peak year (1999) (figure 7-6).<sup>4</sup> The time devoted to “science, space, and technology” coverage in the network nightly news has been on a downward trend since 2003, while the time devoted to “biotechnology and basic medical research,” though considerably lower, has been on the rise in the same period.

Trends in the “science, space, and technology” category, along with recent annual lists of leading individual stories in that category, suggest that developments in the nation’s space program and new ways to use cellular phones and the Internet received the largest amount of news coverage (table 7-2). In the “biotechnology and basic medical research” category, the war on cancer, the use of genetic testing to predict disease, and stem cell research received the largest amount of news coverage. Time devoted to cancer research coverage is greater than for any other story. The importance of

Table 7-2

**Leading nightly news story lines on science and technology, by topic area: 2007 and 2008**

(Annual minutes of coverage)

Topic area/leading story line	2007	Topic area/leading story line	2008
Science, space, and technology		Science, space, and technology	
NASA Space Shuttle program .....	39	Mars astronomy: NASA rovers search for water .....	19
International space station construction .....	31	Spy satellite falls out of orbit, shot down .....	18
NASA astronaut love triangle .....	21	Mathematics education in schools .....	11
NASA astronauts suspected of drunken space flights .....	18	High-technology multitasking is distracting .....	11
Cellular telephone computer combo invented: iPhone .....	14	Cellular telephone extras: ringtones, wallpaper .....	7
Videostreams shared online in viral networks: YouTube <sup>a</sup> .....	12	Internet search engine Yahoo! takeover bid .....	7
Internet used by teens for social networking: Facebook .....	12	International space station construction .....	6
High school science fair competitions held for students .....	10	Physicists build supercollider in Switzerland .....	5
Mathematics education in schools .....	8	Inventions and innovations in technology surveyed .....	5
Inventions and innovations in technology surveyed .....	7	China censors Internet access and e-mail traffic .....	5
Biotechnology/basic medical research		Biotechnology/basic medical research	
War on cancer/research efforts .....	70	War on cancer/research efforts .....	69
Human embryo stem cell biotechnology research .....	27	Genetic DNA biotech analysis predicts diseases .....	29
		Organs may be grown in laboratory for implant .....	12
		Surgery improved by minimally invasive techniques .....	11
		Animal cloning in agriculture safety research .....	6

<sup>a</sup>Refers to the rise of YouTube as a video file-sharing technology.

NOTES: Data reflect annual minutes of story coverage on these topics by major networks ABC, CBS, and NBC, out of approximately 15,000 total annual minutes on weekday nightly newscasts. Shown are the story lines receiving at least 5 minutes of coverage in 2007 and 2008. Excluded from science, space, and technology are stories on forensic science and media content. Excluded from biotechnology and basic medical research are stories on clinical research and medical technology.

SOURCE: Tyndall Report, special tabulations (January 2009), <http://www.tyndallreport.com>, accessed 23 September 2009.

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competing stories, such as the economic crisis, plays a role in deciding what news is covered.

### International Comparisons

Using identical questions, recent surveys conducted in other countries indicate that the overall level of self-reported public interest in S&T is lower than in the United States. Between 75% and 80% of survey respondents in South Korea, China, and Europe said they were “very” or “moderately” interested in “new scientific discoveries” and “use of new inventions and technologies” compared to 86% and 88% respectively of Americans in the 2008 GSS, respectively (appendix table 7-4) (KOFAC 2009; CRISP 2008; EC 2005). Using slightly different questions, about three-quarters of Brazilians said they were “very interested” or “a little interested” in “science and technology” (MCT of Brazil 2006). In Malaysia, 58% of the respondents said they were “interested” or “very interested” in the “latest inventions in new technology” and 51% in the “latest inventions in science” (MASTIC 2004).

In the 2005 European survey (called the 2005 “Eurobarometer”), there was considerable variation among different countries in self-reported interest in S&T-related issues, and the overall level of interest was down from the most recent survey in 1992. In both the United States and in Europe, men showed more interest in S&T than women. For more recent European data on interest in scientific research in general, see sidebar “Scientific Research in the Media in Europe.”<sup>5</sup>

Interest in environmental issues is similarly high in the United States, Europe, South Korea, and Brazil—about 9 in 10 respondents in each country or region expressed interest in this topic, although slight variations in survey terminology should be taken into account.<sup>6</sup> In Malaysia, interest in “environmental pollution” was lower (61% said they were “interested” or “very interested” in this issue).

Like Americans, Europeans and Brazilians are more interested in medicine than in S&T in general. In the United States, nearly everyone was interested in new medical discoveries (94%); in Brazil, most people (91%) were interested in “medicine and health” issues. In Europe, South Korea, and China, interest in new medical discoveries seemed to be lower—between 77% and 83% said they were “very” or “moderately” interested in this issue. In Malaysia, 59% indicated they were “interested” or “very interested” in the “latest inventions in the field of medicine.”<sup>7</sup>

### Involvement

Involvement with S&T outside the classroom in informal, voluntary, and self-directed settings—such as museums, science centers, zoos, and aquariums—is an indicator of interest in S&T.<sup>8</sup> By offering visitors the flexibility to pursue individual curiosity, such institutions provide a kind of exposure to S&T that is well suited to helping people develop further interest.

In the 2008 GSS, 59% of Americans indicated that they had visited an informal science venue during the previous

## Scientific Research in the Media in Europe

In 2007, the European Commission conducted a survey to learn how to motivate European citizens to become more involved in science, research, and innovation. Face-to-face interviews were conducted in people’s homes, in their national language, in the European Union’s (EU) 27 member states (EC 2007).

The survey shows that the majority of Europeans (57%) are “very” and “fairly” interested in scientific research. Interest is much higher in the EU-15 (62%) than in the 12 countries that recently joined (38%). The countries most interested in scientific research were Sweden, Denmark, France, Luxembourg, the Netherlands, Belgium, and Finland. Men and more highly educated individuals expressed more interest in this subject. Medicine attracted the highest degree of public interest (62%), followed by the environment (43%).

Television is the most popular medium for information and also the medium with the widest reach. The majority of EU citizens (61%) watch television programs about scientific research regularly or occasionally, nearly half read scientific articles in general newspapers and magazines, and 28% look at information on scientific issues on the Internet. Television is also the most trusted

medium for obtaining science information, ranking first in trustworthiness in 25 out of the 27 EU member states.

Overall, EU-27 citizens are satisfied with media coverage of scientific research, in particular those who are interested in this subject. The majority believe the coverage devoted to scientific research in the media is sufficient, but about one-third believes that it is not given enough importance. Most European citizens view science media coverage as reliable, objective, useful, varied, and sufficiently visual. However, they also express that science media coverage is difficult to understand, removed from their actual concerns, and not entertaining. More highly educated respondents are more likely to view media coverage of scientific information as more useful, understandable, entertaining, and not too far removed from citizen concerns.

Europeans tend to prefer to receive short news reports about scientific research on a regular basis (43%) rather than occasional in-depth information (34%). In addition, they prefer to restrict public scientific debates to scientists and experts rather than to actively participate themselves, and they would prefer that scientists rather than journalists present scientific information.

year<sup>9</sup> (appendix table 7-6). Half said they had visited a zoo or aquarium and over one-quarter had visited a “natural history museum” (27%) or a “science and technology museum” (26%). One in three Americans had visited an art museum and 64% had visited a public library. These data are generally consistent with data collected by the Pew Internet and American Life Project and the Institute for Museum and Library Services (for more detail on these surveys, see NSB 2008). Among those who visited each of these institutions, the number of annual visits was highest for public libraries, which averaged about 15 visits per year.

The proportion of respondents who reported attending the three institutions (zoo/aquarium, S&T museum, and public library) is down slightly from the last time these questions were asked in 2001. However, these differences may be due to changes in the data collection methods over this period discussed earlier in the chapter, rather than to actual changes in attendance.

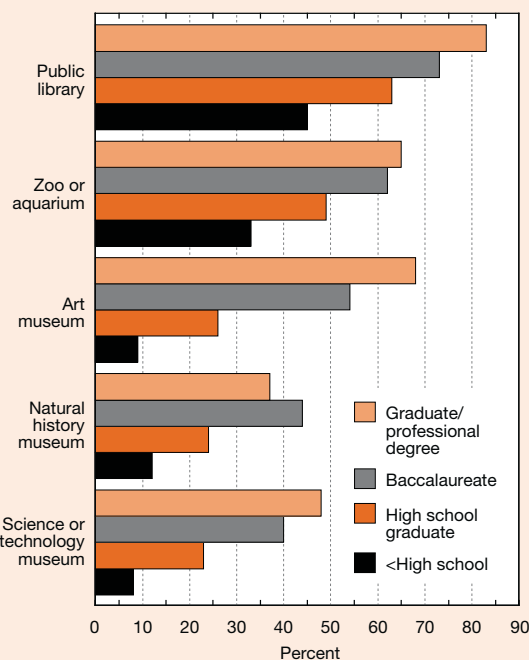
Respondents in households with children 18 or younger were more likely to visit a zoo or aquarium, a public library, and also a natural history museum. Minors in the household did not make a difference in the proportion of adults who visited an art museum or an S&T museum (appendix table 7-7).

Americans with more years of formal education are more likely than others to engage in these informal science activities (figure 7-7; appendix table 7-7). Those in higher income brackets are more likely to have attended a zoo or an aquarium, a natural history or an S&T museum, or an art museum, but just as likely as those in the lowest income bracket to have visited a public library. In general, visits to informal science institutions are lower among Americans who are 65 or older.

In addition, respondents who get most of their information about S&T from the Internet or use this medium to learn about scientific issues are more likely to have visited any informal science institution, even after controlling for expressed interest in scientific issues. This suggests that use of these different sources of exposure to science information complement, rather than replace, one another.

Fewer Europeans report visits to informal science institutions (EC 2005). In the EU-25, about 27% of adults said they had visited a zoo or aquarium, 16% said they had visited a “science museum or technology museum or science centre,” and 8% said they had attended a “science exhibition or science ‘week.’” As in the United States, older and less-educated Europeans reported less involvement in these activities. In addition, European adults in households with more inhabitants more often reported informal science activities. Insofar as household size indicates the presence of minor children, this probably indicates another parallel with the United States. One demographic pattern is notably different between Europe and the United States: where European men (19%) are much more likely than women (13%) to visit informal science or technology museums and centers, these gender differences do not exist in the United States (appen-

**Figure 7-7**  
**Attendance at informal science and other cultural institutions, by institution type and education level: 2008**



NOTE: Percent indicates respondents who had attended the noted institution at least once.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix table 7-7.

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dix table 7-7). (For additional details on the comparison with European data, see NSB 2008.)

Compared with the United States, visits to natural history and science and technology museums are less common in Japan, South Korea, China, Brazil, and Russia (table 7-3). The proportion of respondents who indicated they had visited a zoo/aquarium is similar in the U.S., China, and Japan. Unmeasured differences in the prevalence and accessibility of informal science learning opportunities across countries make it difficult to attribute different visit patterns to differences in interest.

## Public Knowledge About S&T

Scientific literacy can be relevant to the public policy and personal choices that people make. In developing measures for scientific literacy across nations, the Organisation for Economic Co-operation and Development (OECD) (2003) noted that literacy had several components:

Current thinking about the desired outcomes of science education for all citizens emphasizes the development of a general understanding of important concepts and

Table 7-3

**Visits to informal science and other cultural institutions, by country/region: Most recent year**

(Percent)

Institution	United States, 2008	South Korea, 2008	China, 2007	Brazil, 2006	EU, 2005	Russia, 2003	Japan, 2001
Zoo/aquarium <sup>a</sup> .....	50	36	52	28	27	9	43
Natural history museum .....	27	NA	14	NA	NA	NA	20
Science/technology museum <sup>b</sup> .....	26	11	17	4	16	1	13
Public library.....	64	34	41	25	34	16	47
Art museum.....	32	34	18	12	23	7	35

NA = not available, question not asked

EU = European Union

<sup>a</sup>“Zoo, botanic garden, or environmental park” for Brazil, “Zoo, aquarium, or botanic garden” for China, “Zoo” for Russia.<sup>b</sup>“Science museums or technology museums or science centers” for EU.

NOTES: Responses to (United States, Japan, Korea) *I am going to read you a short list of places and ask you to tell me how many times you visited each type of place during the last year, that is, the last 12 months* (Percentage includes those who visited each institution one or more times); (EU, Russia, China, Brazil) *Which of the following have you visited in the last twelve months* (Multiple answers possible).

SOURCES: (United States) University of Chicago, National Opinion Research Center, General Social Survey (2008); Korea Foundation for the Advancement of Science and Creativity (formerly Korea Science Foundation), Survey of Public Attitudes Toward and Understanding of Science and Technology (2008); Chinese Ministry of Science and Technology, *Chinese Public Understanding of Science and Attitudes towards Science and Technology*, 2007 (2008); (Brazil) Ministry of Science and Technology, *Public Perceptions of Science and Technology* (2007); (EU) Eurobarometer 224/Wave 63.1: Europeans, Science and Technology (2005); (Russia) British Council, *Russian Public Opinion of the Knowledge Economy* (2004); Japan National Institute of Science and Technology Policy, The 2001 Survey of Public Attitudes Toward and Understanding of Science & Technology in Japan (2001). See appendix table 7-6 for U.S. trends.

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explanatory frameworks of science, of the methods by which science derives evidence to support claims for its knowledge, and of the strengths and limitations of science in the real world. It values the ability to apply this understanding to real situations involving science in which claims need to be assessed and decisions made...

Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity. (pp. 132–33)

As the reference to changes made through human activity makes clear, the OECD definition implies an understanding of technology. The OECD takes the view that literacy is a matter of degree and that people cannot simply be classified as either literate or not literate.

A good understanding of basic scientific terms, concepts, and facts; an ability to comprehend how science generates and assesses evidence; and a capacity to distinguish science from pseudoscience are widely used indicators of scientific literacy. (For a different perspective on scientific literacy, see sidebar, “Asset-Based Models of Knowledge.”)

U.S. survey data indicate that many Americans cannot provide correct answers to basic questions about scientific facts and do not apply appropriate reasoning strategies to questions about selected scientific issues. Residents of other countries, including highly developed ones, perform no better, on balance, when asked similar questions. However,

compared to middle-school students, American adults perform relatively well. In light of the limitations of using a small number of questions largely keyed to knowledge taught in school, generalizations about American’s knowledge of science should be made cautiously.

## Understanding Scientific Terms and Concepts

### U.S. Patterns and Trends

U.S. data show that the public’s level of factual knowledge about science has not changed much over time. Figure 7-8 shows average numbers of correct answers to a series of mostly true-false science questions in different years for which fully comparable data were collected (appendix table 7-8).<sup>10</sup> Although performance on individual questions varies somewhat over time (appendix table 7-9), overall scores are relatively similar.

Factual knowledge of science is positively related to people’s level of formal schooling, income level, and the number of science and math courses they have taken. Factual knowledge is also positively related to scores on a 10-item vocabulary test included in the GSS, which scholars in many disciplines have often used to assess verbal skills (Malhotra, Krosnick, and Haertel 2007).<sup>11</sup> In the factual questions included in NSF surveys since 1979, which allow for the observation of trends over time (referred to as “trend factual questions” below), men score higher on the questions in the physical sciences and women score higher on those in the biological sciences (table 7-4).<sup>12</sup>

Respondents 65 and older are less likely than others to answer the questions correctly (appendix tables 7-8 and 7-10). An analysis of surveys conducted between 1979 and 2006 concluded that generational experiences are more important than cognitive declines associated with aging in explaining these differences (Losh 2009, 2010).

The factual knowledge questions that have been repeatedly asked in U.S. surveys involve information that was being taught in grades K–12 when most respondents were young. Because science continually generates new knowledge that reshapes how people understand the world, scientific

literacy requires lifelong learning so that citizens become familiar with terms, concepts, and facts that emerged after they completed their schooling.

In 2008, the GSS asked Americans questions that tested their knowledge of a topic that has not been central to the standardized content of American science education: nanotechnology. Survey respondents who scored relatively well overall on the questions that were asked repeatedly over the years also exhibited greater knowledge of this topic (figure 7-9).<sup>13</sup> Likewise, the educational and demographic characteristics associated with higher scores on the trend factual knowledge questions are also associated with higher scores for this new topic (appendix table 7-11). These data suggest that the knowledge items used to measure trends, although focused on the kind of factual knowledge learned in school, are a reasonable indicator of factual science knowledge in general, including knowledge that is acquired later in life.

Similarly, national standards for what students should know reflect new science concepts beyond those covered by the long-standing questions that measure trends in public knowledge of science. In 2008, the GSS included questions on science and mathematics knowledge that were more closely aligned with national standards for what students should know. The questions were selected from three national exams administered to students and Project 2061, an initiative by the American Association for the Advancement of Science (AAAS) that develops assessment materials aligned

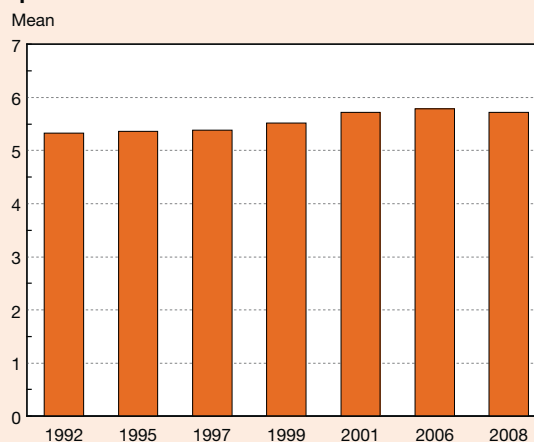
## Asset-Based Models of Knowledge

Many researchers and educators interested in the public's understanding of science advocate studying the skills people bring to bear on scientific issues that they deal with in their daily lives (e.g., gardening, bird-watching). Because individuals encounter S&T in different ways, they acquire different S&T knowledge “assets,” which they then can use to make sense of unfamiliar issues (National Research Council 2009). For researchers and educators who favor an asset-based model of scientific literacy, public understanding of science is less a “generalized body of knowledge and skills that every citizen should have by a certain age” than “a series of specific sets of only moderately overlapping knowledge and abilities that individuals construct over their lifetimes” (Falk, Storksdieck, and Dierking 2007). In education, asset-based perspectives on knowledge have been useful in helping teachers build on children's existing strengths to improve their performance.

Generalized assessments of S&T knowledge may underestimate the assets available to individuals when they deal with S&T matters of greater interest and consequence to them, because these types of assessments ask questions on topics of little interest to many respondents. In contrast, a knowledge assessment that is tailored to an S&T domain with which an individual is familiar might yield very different results. In addition, because people often use their knowledge assets in group interactions, such as a nature outing, some researchers question the value of individual assessments in a test or survey (Roth and Lee 2002).

Researchers have developed measures of adult science understanding to assess how people make sense of specific experiences or scientific materials (Friedman 2008). National indicators that evaluate domain-specific knowledge or group problem-solving are not practical, but a perspective on scientific literacy that stresses domain-specific or group assets is useful, because it points to a significant limitation of generalized indicators of individual scientific literacy.

Figure 7-8  
Correct answers to factual knowledge of science questions: 1992–2008



NOTES: Mean number of correct responses to 9 questions included in “factual knowledge of science, scale 1”; see appendix table 7-8 for explanation and list of questions. See appendix tables 7-9 and 7-10 for responses to individual questions. Includes all years for which data collected.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1992–2001); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008).

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Table 7-4

**Correct answers to scientific literacy questions, by sex: 2001, 2004, 2006, and 2008**

(Percent)

Question	2001	2004	2006	2008
<b>Physical science</b>				
<i>The center of the Earth is very hot. (True)</i>				
Male.....	85	86	85	88
Female.....	76	72	75	80
<i>All radioactivity is man-made. (False)</i>				
Male.....	81	82	77	74
Female.....	71	66	64	67
<i>Lasers work by focusing sound waves. (False)</i>				
Male.....	61	59	62	64
Female.....	30	28	32	34
<i>Electrons are smaller than atoms. (True)</i>				
Male.....	52	52	61	59
Female.....	43	39	48	47
<i>The continents have been moving their location for millions of years and will continue to move. (True)</i>				
Male.....	83	85	85	82
Female.....	74	71	75	73
<i>Does the Earth go around the Sun, or does the Sun go around the Earth? (Earth around Sun)</i>				
<i>How long does it take for the Earth to go around the Sun? (One year)</i>				
Male <sup>a</sup> .....	66	NA	66	58
Female <sup>a</sup> .....	42	NA	46	44
<b>Biological science</b>				
<i>It is the father's gene that decides whether the baby is a boy or a girl. (True)</i>				
Male.....	58	51	55	53
Female.....	72	70	72	71
<i>Antibiotics kill viruses as well as bacteria. (False)</i>				
Male.....	46	49	50	47
Female.....	55	58	61	60
<i>A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. (1) Does this mean that if their first child has the illness, the next three will not? (No); (2) Does this mean that each of the couple's children will have the same risk of suffering from the illness? (Yes)</i>				
Male.....	68	67	72	66
Female.....	67	62	67	63
<i>Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug? Why is it better to test the drug this way? (The second way because a control group is used for comparison)</i>				
Male <sup>b</sup> .....	39	49	42	37
Female <sup>b</sup> .....	38	43	41	39

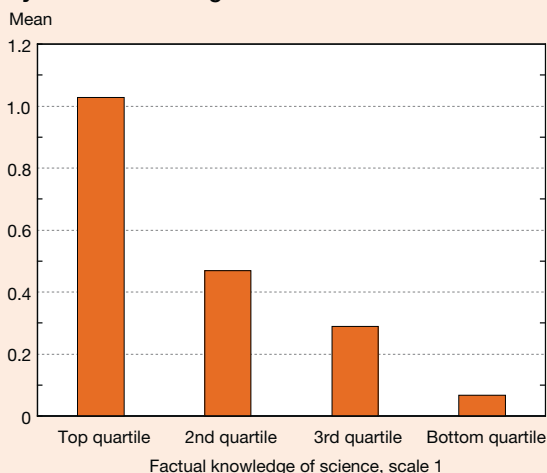
NA = not available

<sup>a</sup> Data represent composite of correct responses to both questions. Second question only asked if first question answered correctly. No composite percentage computed for 2004 because second question not asked.

<sup>b</sup> Data represent a composite of correct responses to both questions.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (2001); University of Michigan, Survey of Consumer Attitudes (2004); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008). See appendix tables 7-9 and 7-10 for factual knowledge questions. See appendix tables 7-13 and 7-14 for scientific process questions (probability and experiment).

Figure 7-9  
Correct answers to nanotechnology questions,  
by factual knowledge of science: 2008



NOTES: Mean number of correct responses to two factual questions on nanotechnology. Respondents saying they had heard “nothing at all” about nanotechnology not asked questions; these respondents count as zero (0) correct. See appendix table 7-11 for responses to nanotechnology questions. See notes to appendix table 7-8 for trend factual knowledge of science questions included in NSF surveys (scale 1).

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008).

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with current curricular standards.<sup>14</sup> This battery of questions included nine factual questions, two questions measuring chart reading and understanding of the statistical concept of “mean,” and five questions that tested reasoning and understanding of the scientific process. Two out of the 16 questions were open-ended and the rest were multiple-choice (see sidebar, “New Science Knowledge Questions”).<sup>15</sup>

The results show that survey respondents who answered the additional factual knowledge questions correctly also tended to provide correct answers to the trend factual knowledge questions (figure 7-10; appendix tables 7-10 and 7-12). This suggests again that the trend factual questions are a reasonable indicator of the type of knowledge students are tested on in national assessments.

Out of seven factual science knowledge questions where comparison scores with fourth and eighth grade students were possible, adult Americans received a higher or similar score in five of them (table 7-5). Comparisons should be made cautiously because of the differences in circumstances in which students and adults responded to these science knowledge questions. Students’ tests were on paper and self-administered, whereas the majority of respondents in the GSS answered orally to an interviewer. Elementary and middle school students had an advantage over adults in that classroom preparation preceded their tests.

## New Science Knowledge Questions

These questions were included in the 2008 General Social Survey to assess different aspects of science and technology knowledge. Answers are bold. The factual knowledge questions (questions 1, 3–5, and 7–11) are combined into scale 2 in some figures and appendix tables. Other questions test a person’s knowledge of charts and statistics (questions 12 and 13), reasoning/life sciences (questions 2 and 14), and experiment/controlling variables (questions 6 and 14–16). Note that the correct answer for question 14 can be reached by using reasoning skills, knowledge in the life sciences, or understanding of the experiment/controlling variables concept.

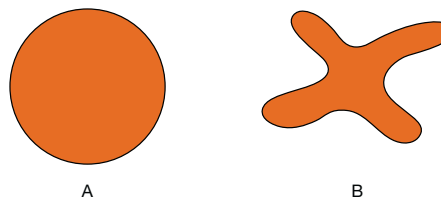
**Opening script:** Now, we are going to do some more detailed questions on science and technology. Scientists and educators are interested in how familiar adults are with the things being taught in today’s schools. Many of these questions are likely to concern things that weren’t taught or emphasized when you were in school. Some of the questions involve pictures or graphs.

1. What property of water is most important for living organisms?

- A) It is odorless.
- B) It does not conduct electricity.
- C) It is tasteless.
- D) It is liquid at most temperatures on Earth.**

2. Please look at Card 1. The two objects shown there have the same mass, but object B loses heat more quickly than object A.

Card 1  
Body Structures and Heat Loss



Which combination of bodily features would be BEST suited to a small animal that lives in a cold climate and needs to minimize heat loss?

- A) Long ears and a long body.
- B) Small ears and a short tail.**
- C) A long nose and a long tail.
- D) A short nose and large ears.
- E) A long tail and a short nose.

## New Science Knowledge Questions *continued*

3. Which of the following is a key factor that enables an airplane to lift?

- A) **Air pressure beneath the wing is greater than that above the wing.**
- B) Pressure within the airplane is greater than that of the outside.
- C) Engine power is greater than that of friction.
- D) The plane's wing is lighter than air.

4. Lightning and thunder happen at the same time, but you see the lightning before you hear the thunder. Explain why this is so.

**A correct response indicates that light travels faster than sound so the light gets to your eye before the sound reaches your ear.**

5. A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color.

**A correct response refers to a neutralization or a chemical reaction that results in products that do not react with litmus paper.**

6. Please look at Card 2. A student wants to find out if temperature affects the behavior of goldfish. He has 4 fish bowls and 20 goldfish. Which of the experiments on Card 2 should he do? **Correct answer: A.**

7. A farmer thinks that the vegetables on her farm are not getting enough water. Her son suggests that they use water from the nearby ocean to water the vegetables. Is this a good idea?

- A) Yes, because there is plenty of ocean water.
- B) Yes, because ocean water has many natural fertilizers.
- C) **No, because ocean water is too salty for plants grown on land.**
- D) No, because ocean water is much more polluted than rainwater.

8. Which one of the following is NOT an example of erosion?

- A) The wind in the desert blows sand against a rock.
- B) A glacier picks up boulders as it moves.
- C) A flood washes over a riverbank, and the water carries small soil particles downstream.
- D) **An icy winter causes the pavement in a road to crack.**

Card 2

A



Number of fish	5 fish	5 fish	5 fish	5 fish
Temperature	15°C	20°C	25°C	30°C

B



Number of fish	6 fish	6 fish	4 fish	4 fish
Temperature	20°C	20°C	30°C	30°C

C



Number of fish	8 fish	6 fish	4 fish	2 fish
Temperature	25°C	25°C	25°C	25°C

D



Number of fish	8 fish	6 fish	4 fish	2 fish
Temperature	15°C	20°C	25°C	30°C

9. Traits are transferred from generation to generation through the...

- A) sperm only.
- B) egg only.
- C) **sperm and egg.**
- D) testes.

10. How do most fish get the oxygen they need to survive?

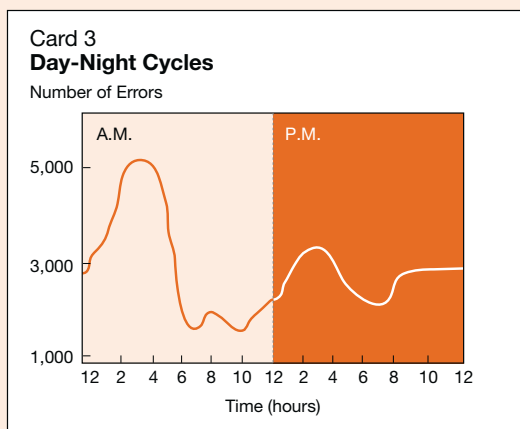
- A) They take in water and break it down into hydrogen and oxygen.
- B) **Using their gills, they take in oxygen that is dissolved in water.**
- C) They get their oxygen from the food they eat.
- D) They come to the surface every few minutes to breathe air into their lungs.

### New Science Knowledge Questions *continued*

11. For which reason may people experience shortness of breath more quickly at the top of a mountain than along a seashore?

- A) A slower pulse rate.
- B) A greater gravitational force on the body.
- C) A lower percent of oxygen in the blood.**
- D) A faster heartbeat.
- E) A slower circulation of blood.

12. Please look at Card 3. Day-night rhythms dramatically affect our bodies. Probably no body system is more influenced than the nervous system. The figure on Card 3 illustrates the number of errors made by shift workers in different portions of the 24-hour cycle.



Based on the data illustrated in the figure, during which of these time periods did the most errors occur?

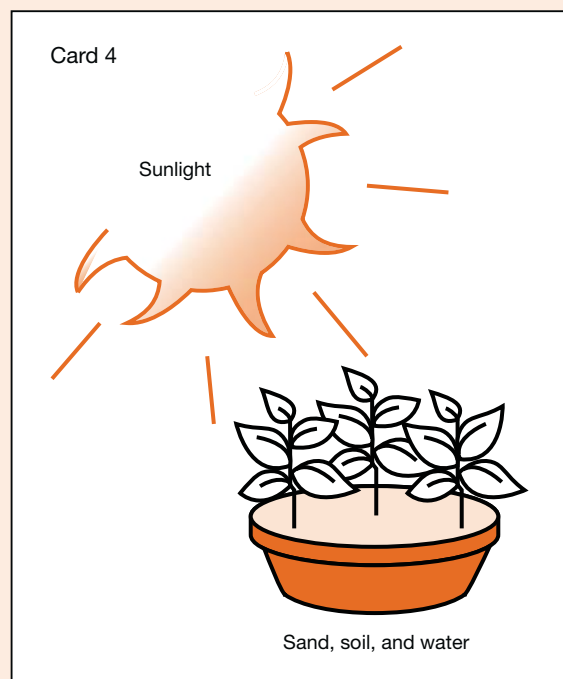
- A) 2 A.M. to 4 A.M.**
- B) 8 A.M. to 10 A.M.
- C) 12 P.M. to 2 P.M.
- D) 2 P.M. to 4 P.M.
- E) 8 P.M. to 10 P.M.

13. As part of a laboratory experiment, five students measured the weight of the same leaf four times. They recorded 20 slightly different weights. All of the work was done carefully and correctly. Their goal was to be as accurate as possible and reduce error in the experiment to a minimum.

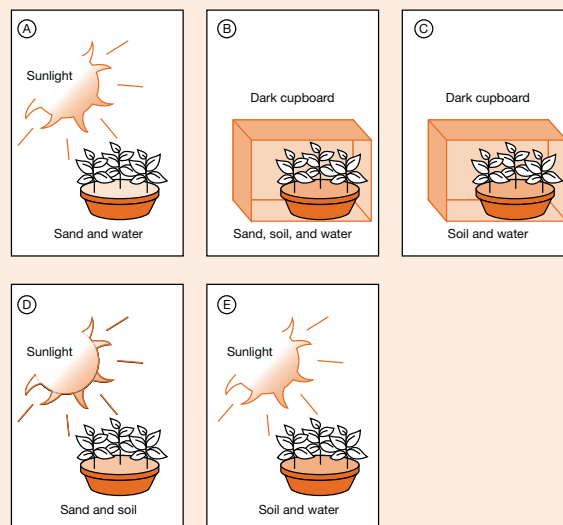
Which of the following is the BEST method to report the weight of the leaf?

- A) Ask the teacher to weigh the leaf.
- B) Report the first measurement.
- C) Average all of the weights that were recorded.**
- D) Average the highest and lowest weights recorded.
- E) Discard the lowest five weights.

14. Please look at Card 4. A gardener has an idea that a plant needs sand in the soil for healthy growth. In order to test her idea she uses two pots of plants. She sets up one pot of plants as shown on the top part of the card. Which one of the pictures on the bottom part of the card shows what she should use for the second pot? **Correct answer is E.**

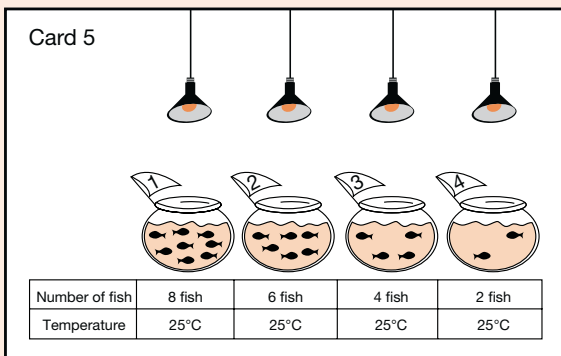


Which ONE of the following should she use for the second pot of plants?



## New Science Knowledge Questions *continued*

15. Please look at Card 5. What is the scientist trying to find out from this experiment?



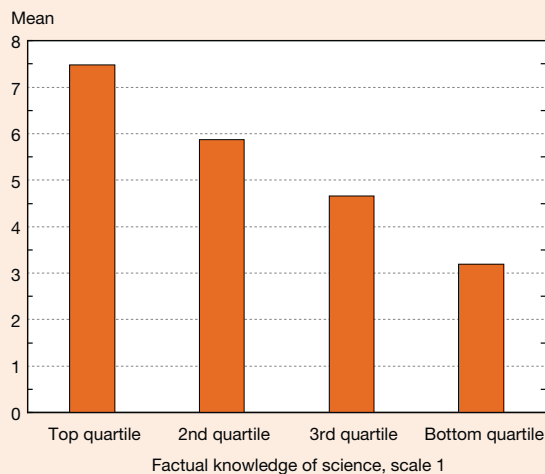
- A) If the number of fish in the fish bowl affects the behavior of the fish.
- B) If the temperature of the fish bowl affects the behavior of the fish.
- C) If the temperature and the amount of light affect the behavior of the fish.
- D) If the number of fish, the temperature, and the amount of light affect the behavior of the fish.
16. Why did you choose that answer?
- A) Because I already know what affects the behavior of fish.
- B) Because that is what is allowed to change in this experiment.**
- C) Because that is what stays the same in this experiment.
- D) Because that is what the scientist decided to include in this experiment.

The variation patterns on these items were similar to the trend factual questions. However, men scored higher than women in all but one of the additional factual knowledge questions included in the 2008 GSS (appendix tables 7-10 and 7-12).

### International Comparisons

Adults in different countries and regions have been asked identical or substantially similar questions to test their factual knowledge of science. (For an examination of how question wording is related to international differences in knowledge measures, see sidebar, “Knowledge Difference or Measurement Error?”) Knowledge scores for individual

Figure 7-10  
Correct answers to new factual knowledge questions, by trend factual knowledge questions: 2008



NOTES: Mean number of correct responses to nine new factual questions included in scale 2; see appendix table 7-12 for questions. See notes to appendix table 7-8 for questions included in scale 1.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008).

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items vary from country to country, and no country consistently outperforms the others (figure 7-11). For the questions reported in figure 7-11, knowledge scores are relatively low in China, Russia, and Malaysia. Compared with the United States and the highly developed countries in Europe, Japanese scores are also relatively low.<sup>16</sup>

Science knowledge scores vary considerably across the EU-25 countries, with northern European countries, led by Sweden, recording the highest total scores on a set of 13 questions. For a smaller set of 4 items that were administered in both 1992 and 2005 in 12 European countries, each country performed better in 2005. In contrast, the U.S. data on science knowledge do not show upward trends over the same period. In Europe, as in the United States, men, younger adults, and more highly educated people tend to score higher on these questions. (For more details on scientific literacy in individual countries in Europe, see NSB 2008.)

### Reasoning and Understanding the Scientific Process

Past NSF surveys have used questions on three general topics—probability, experimental design, and the scientific method—to assess trends in Americans’ understanding of the process of scientific inquiry. One set of questions tests how well respondents apply principles of probabilistic reasoning to a series of questions about a couple whose children

Table 7-5

**Adult and student correct answers to factual knowledge questions**

(Percent correct)

Factual questions	Field of study	Concepts measured	U.S. adult	Student		Question source
			2008 General Social Survey	United States	International	
1. <i>A farmer thinks that the vegetables on her farm are not getting enough water. Her son suggests that they use water from the nearby ocean to water the vegetables. Is this a good idea?</i>	Earth and space sciences	Water cycle; nature of the oceans and their effects on water and climate; location of water, its distribution, characteristics, and its effect and influence on human activity	86	61	NA	NAEP 2005, 4th grade
2. <i>Traits are transferred from generation to generation through the...</i>	Life sciences	Reproduction and heredity	80	86	74	TIMSS Science 2003, 8th grade
3. <i>How do most fish get the oxygen they need to survive?</i>	Life sciences	Change and evolution; adaptation and natural selection	76	78	NA	NAEP 2005, 8th grade
4. <i>What property of water is most important for living organisms?</i>	Physical sciences	Matter and its transformations	69	76	NA	NAEP 2000, 8th grade
5. <i>Which of the following is NOT an example of erosion?</i>	Earth and space sciences	Composition of the Earth; forces that alter the Earth's surface; rocks: their formation, characteristics, and uses; soil: its changes and uses; natural resources used by humankind; and forces within the Earth	55	37	NA	NAEP 2005, 8th grade
6. <i>Lightning and thunder happen at the same time, but you see the lightning before you hear the thunder. Explain why this is so.</i>	Physical sciences	Frames of reference, force and changes in position and motion, action and reaction, vibrations and waves as motion, electromagnetic radiation, and interactions of electromagnetic radiation with matter	45	36	NA	NAEP 2005, 8th grade
7. <i>A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color. Explain why the litmus paper does not change color in the mixed solution.</i>	Chemistry	Acids and bases	20	17	21	TIMSS 2003, 8th grade

NA = not available, question not asked

NAEP = National Assessment of Educational Progress; TIMSS = Trends in International Mathematics and Science Study

NOTES: Questions appeared in 2008 General Social Survey. Original sources of questions are NAEP and TIMSS. For complete questions, see sidebar: "New Science Knowledge Questions."

SOURCES: University of Chicago, National Opinion Research Center, General Social Survey (2008), see appendix table 7-12; NAEP, <http://nces.ed.gov/nationsreportcard/itmrls/startsearch.asp>, accessed 22 September 2009; and TIMSS, <http://nces.ed.gov/timss/results03.asp>, accessed 22 September 2009.

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## Knowledge Difference or Measurement Error?

Surveys from different countries have tried to measure public knowledge about how children inherit the chromosomes that determine their sex. The data appear to indicate that Americans understand this topic better than their counterparts in other countries. The true-false question asked in the United States is “It is the father’s gene that decides whether the baby is a boy or a girl.” (True.) Europeans and Chinese have been asked the same question about the mother’s gene. (False.) Although a knowledgeable survey respondent would treat these questions as equivalent, research on how people answer surveys suggests that they may not be. Survey methodologists have found that many respondents exhibit an acquiescence bias—a tendency to give a positive answer (e.g.,

true, yes, agree) to questions, independent of their content (Holbrook, Green, and Krosnick 2003; Krosnick 2000). Accordingly, respondents will seem more knowledgeable when the correct answer to a question is “true.”

The 2008 GSS included an experiment to test whether observed national differences on this topic are real knowledge differences or are products of acquiescence bias. Some respondents were asked the usual U.S. question, while others got the international variant. The experiment indicated that the national differences result from knowledge differences and not from acquiescence bias. A larger proportion of respondents (71%) answered correctly when the right answer was false than when it was true (62%) (appendix tables 7-9 and 7-10).

have a one-in-four chance of suffering from an inherited disease.<sup>17</sup> A second set of questions deals with the logic of experimental design, asking respondents about the best way to design a test of a new drug for high blood pressure. An open-ended question probes what respondents think it means to “study something scientifically.” Because probability, experimental design, and the scientific method are all central to scientific research, these questions are relevant to how respondents evaluate scientific evidence.

In 2008, 65% of Americans responded correctly to the two questions about probability, 38% to the questions testing the concept of experiment, and 22% to the questions testing the concept of scientific study. Scores on the probability questions fluctuate each year but are relatively stable over time; however, between 2006 and 2008 the combined scores of the two probability questions slightly declined. Scores in the other scientific process questions were generally higher than they were in the mid-1990s, but decreased somewhat in 2008 (appendix table 7-13). Performance on these questions is strongly associated with the different measures of science knowledge and education (appendix table 7-14). Older Americans and those with lower incomes, two groups that tend to have less education in the sciences, also score lower on the inquiry measures. Men and women obtain similar scores on these questions (tables 7-4 and 7-6).

The 2008 GSS included several additional questions on the scientific process that provide an opportunity to examine Americans’ understanding of experimental design in more detail and benchmark their scores to national results of middle school students. From 29% to 57% of Americans responded correctly to questions measuring the concepts of scientific experiment and controlling variables (appendix tables 7-13 and 7-15). However, only 12% of Americans responded correctly to all the questions on this topic and nearly 20% of Americans did not respond correctly to any of them (figure 7-12).<sup>18</sup> These data suggest that relatively few

Americans have a generalized understanding of experimental design that they can reliably apply to different situations.

The proportion of Americans with a strong grasp of experimental design does not vary by sex. However, Americans who answered at least three of four experimental knowledge questions correctly were more likely to have a college education or higher, have taken more courses in math and science, and have a clear understanding of the scientific method. They are also more likely to be in the top income bracket and to respond correctly to factual science knowledge and probability questions.

Adults’ scores in the experimental knowledge questions are similar to middle school students in one question (question 2 in table 7-7) but lower in two others, out of the three questions where the comparison was possible.

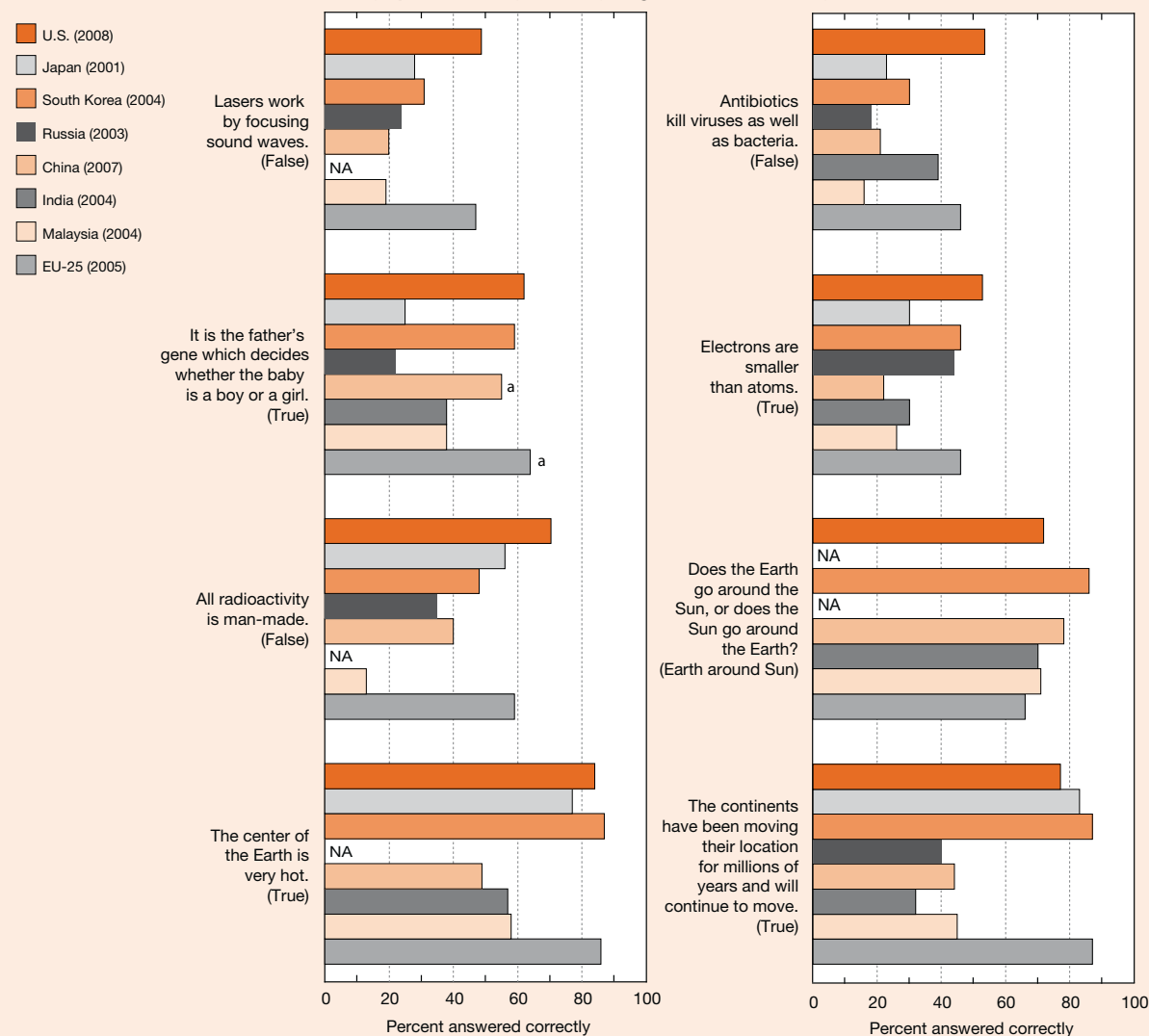
## Understanding of Statistics and Charts

Americans encounter basic statistics and charts in everyday life. Many media reports cite studies in health, social, economic, and political trends. Understanding statistical concepts is important to understanding the meaning of these studies and consequently to scientific literacy (Crettaz von Roten 2006). The results from the 2008 GSS show that 77% of Americans can read a simple chart correctly and 66% understand the concept of “mean” in statistics. Understanding these two concepts is associated with formal education, the number of math and science courses taken, income, and verbal ability. Older respondents were less likely to respond correctly to these two questions (appendix table 7-15).

## Pseudoscience

The results of 13 NSF-funded surveys conducted between 1979 and 2008 show a trend toward fewer Americans seeing astrology as scientific. In the 2008 GSS 63% of Americans indicated they believed that astrology was “not at all

Figure 7-11

**Correct answers to scientific literacy questions, by country/region: Most recent year**

NA = not available, question not asked

EU = European Union

\*China and Europe surveys asked about "mother's gene" instead of "father's gene."

SOURCES: University of Chicago, National Opinion Research Center, General Social Survey (2008); Japan—Government of Japan, National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology, The 2001 Survey of Public Attitudes Toward and Understanding of Science and Technology in Japan (2002); South Korea—Korea Science Foundation, Survey of Public Attitudes Toward and Understanding of Science and Technology (2004); Russia—Gokhberg L, Shuvalova O, *Russian Public Opinion of the Knowledge Economy: Science, Innovation, Information Technology and Education as Drivers of Economic Growth and Quality of Life*, British Council, Russia (2004); China—Wei H, Chao Z, Hongbin G, *Chinese Public Understanding of Science and Attitudes towards Science and Technology, 2007*, China Research Institute for Science Popularization, Chinese Ministry of Science and Technology (2008); India—National Council of Applied Economic Research, India Science Survey (2004); Malaysia—Malaysian Science and Technology Information Centre, Public Awareness of Science and Technology Malaysia 2004 (2005); and EU—European Commission, Research Directorate-General, Eurobarometer 224/Wave 63.1: Europeans, Science and Technology (2005).

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Table 7-6

**Correct answers to questions about charts and statistics, reasoning/life sciences, and understanding of experiment/controlling variable by sex: 2008**

(Percent)

Question	Both sexes	Men	Women
1. Please look at card 3. Day-night rhythms dramatically affect our bodies. Probably no body system is more influenced than the nervous system. The figure on card 3 illustrates the number of errors made by shift workers in different portions of the 24-hour cycle. Based on the data illustrated in the figure, during which of these time periods did the most errors occur? .....	77	80	73
2. As part of a laboratory experiment, five students measured the weight of the same leaf four times. They recorded 20 slightly different weights. All of the work was done carefully and correctly. Their goal was to be as accurate as possible and reduce error in the experiment to a minimum. Which of the following is the BEST method to report the weight of the leaf?.....	66	70	63
3. Please look at card 1. The two objects shown there have the same mass, but object B loses heat more quickly than object A. Which combination of bodily features would be BEST suited to a small animal that lives in a cold climate and needs to minimize heat loss? <sup>a</sup> .....	51	54	49
4. Please look at card A. A gardener has an idea that a plant needs sand in the soil for healthy growth. In order to test her idea she uses two pots of plants. She sets up one pot of plants as shown on the top part of the card. Which one of the pictures on the bottom part of the card shows what she should use for the second pot? <sup>b</sup> .....	51	49	53
5. Please look at card 2. A student wants to find out if temperature affects the behavior of goldfish. He has four fish bowls and 20 goldfish. Which of the experiments on card 2 should he do? .....	57	59	56
6. Combined responses to two interrelated questions: (Question 1) What is the scientist trying to find out from this experiment? (Question 2, follow-up) Why did you choose that answer? <sup>c</sup> .....	29	30	28

<sup>a</sup> Respondent can reach correct answer through both reasoning and knowledge of life sciences.<sup>b</sup> Respondent can answer this question by using knowledge of experiment/controlling variable or knowledge in the life sciences.<sup>c</sup> Data represent a composite of correct responses to both questions.

NOTE: For complete questions, see sidebar: "New Science Knowledge Questions Included in the General Social Survey: 2008."

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix table 7-15. Questions 1, 2, and 3 originally from American Council on Education, GED Testing Service, Science Official GED Practice Test (2006). Question 4 originally from Trends in International Mathematics and Science Study (TIMSS), Complete TIMSS 8 Science Concepts and Items 4, [http://nces.ed.gov/timss/pdf/TIMSS8\\_Science\\_Items.pdf](http://nces.ed.gov/timss/pdf/TIMSS8_Science_Items.pdf), accessed 22 September 2009. Questions 5 and 6 originally from American Association for the Advancement of Science, AAAS Project 2061, [http://www.project2061.org/publications/2061Connections/2007/media/controlling\\_variables\\_poster.pdf](http://www.project2061.org/publications/2061Connections/2007/media/controlling_variables_poster.pdf), accessed 22 September 2009.

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scientific" and 28% said that it was only "sort of scientific." Respondents with more years of formal education were less likely to perceive astrology to be at all scientific. In 2008, 78% of college graduates indicated that astrology was "not at all scientific," compared with 60% of high school graduates. Those who scored highest on the factual knowledge measures were less likely to perceive astrology to be at all scientific (78%) than those who scored lowest (45%). Respondents who correctly understood the concept of scientific inquiry were more likely to say that astrology was not at all scientific (74%) than those who did not understand the concept (57%). However, the youngest age group (18–24) was less likely to say astrology is "not at all scientific" (49%) and more likely to say it was "sort of scientific" (44%) (appendix table 7-16).<sup>19</sup>

## Public Attitudes About S&T in General

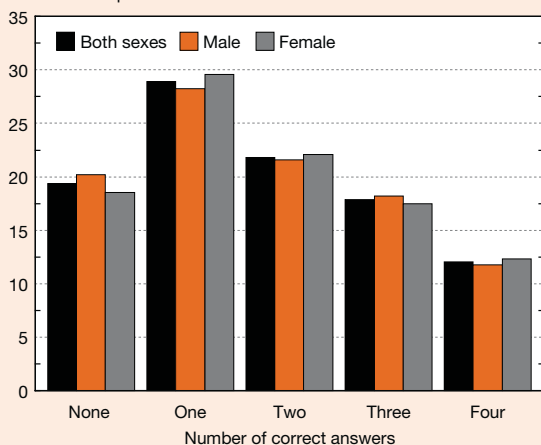
Generalized public support for S&T can make a difference in many ways. Public openness to technological change gives U.S. businesses opportunities to build a domestic

customer base, create a foundation for worldwide technical competitiveness, and foster the national advantages that flow from pioneering innovations. Broad public and political support for long-term commitments to S&T research, especially in the face of pressing immediate needs, enables ambitious proposals for sustained federal S&T investments to reach fruition. Public confidence that S&E community leaders are trustworthy, S&E research findings are reliable, and S&E experts bring valuable judgment and knowledge to bear on public issues permits scientific knowledge to have influence over practical affairs. In addition, positive public perceptions of S&E occupations encourage young people to pursue S&E careers.

To be sure, claims of scientific and technological progress should be evaluated critically. But widespread public skepticism about S&T, going beyond the reasoned examination of particular cases, would represent a consequential change in American public opinion. Changing public opinion could affect national strategies that link progress in S&T to overall national progress.

Figure 7-12  
Correct answers to four questions testing concept of experiment/controlling variable, by sex: 2008

Percent of respondents



NOTE: For the four questions testing concept of experiment/controlling variable included see "Understanding of experiment" in appendix table 7-13 and "Experiment/controlling variable" group in appendix table 7-15.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008).

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This section presents general indicators of public attitudes and orientations toward S&T in the United States and in other countries. It covers views of the promise of S&T and reservations about science, overall support for government funding of research, confidence in the leadership of the scientific community, perceptions of the proper influence of scientists over controversial public issues about which the research community claims expertise, perceptions about what it means to be scientific and which disciplines and practices are scientific, and views of S&E as occupations.

### Promise and Reservations

NSF surveys dating back to 1979 show that Americans endorse the past achievements and future promise of S&T. In practically any major American social grouping, few individuals express serious doubt about the promise of science. In 2008, 43% of GSS respondents said that the benefits of scientific research strongly outweighed the harmful results and substantial percentages said that benefits either slightly outweighed harms (25%) or volunteered that the two were about equal (16%). Only 10% of respondents said that the harms either slightly or strongly outweighed benefits and the remainder said that they did not know. These numbers were generally consistent with those from earlier surveys (figure 7-13; appendix tables 7-17 and 7-18). Americans overwhelmingly agree that S&T will foster "more opportunities

Table 7-7  
Adult and student correct answers to scientific process questions  
(Percent correct)

Process question	Field of study	U.S. adult	Student		Question source
		2008 General Social Survey	United States	International	
1. Please look at Card A. A gardener has an idea that a plant needs sand in the soil for healthy growth. In order to test her idea she uses two pots of plants. She sets up one pot of plants as shown on the top part of the card. Which one of the pictures on the bottom part of the card shows what she should use for the second pot? <sup>a</sup> .....	Life sciences	51	70	58	TIMSS Science 2003, 8th grade
2. Please look at Card 5. What is the scientist trying to find out from this experiment?.....	Life sciences	40	38	NA	AAAS Project 2061
3. (Follow-up to question 2) Why did you choose that answer? .....	Life sciences	38	46	NA	AAAS Project 2061

NA = not available, question not asked

AAAS = American Association for the Advancement of Science; TIMSS = Trends in International Mathematics and Science Study.

<sup>a</sup> Respondent can answer this question by using knowledge of experiment/controlling variable or knowledge in the life sciences.

NOTES: Questions appeared in 2008 General Social Survey. Original sources of questions are TIMSS and AAAS Project 2061. For complete questions, see sidebar: "New Science Knowledge Questions Included in the General Social Survey: 2008."

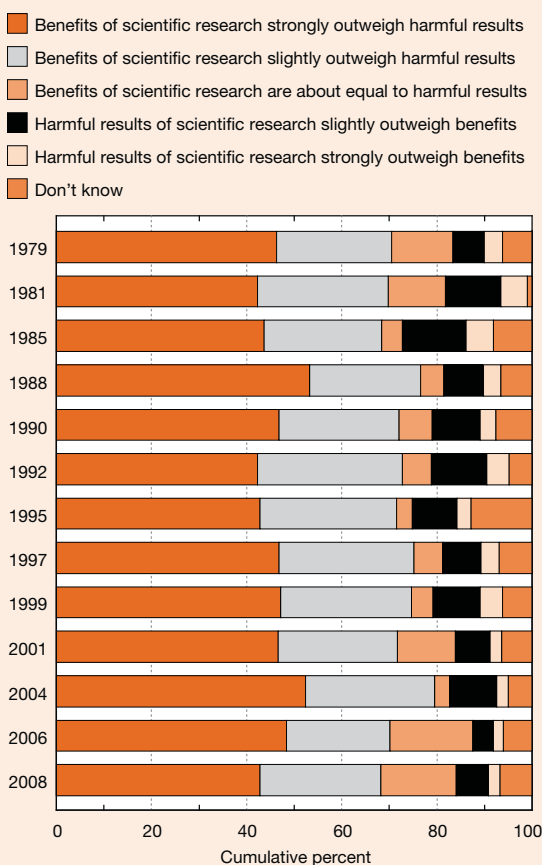
SOURCES: University of Chicago, National Opinion Research Center, General Social Survey (2008), see appendix table 7-15; TIMSS, <http://nces.ed.gov/timss/results03.asp>; DeBoer GE, Gogos A. Unpublished results of national field test assessing middle school students' understanding of controlling variables, AAAS Project 2061.

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for the next generation,” with about 89% expressing agreement in the 2008 GSS (appendix table 7-19). Agreement with this statement has been increasing moderately for over a decade.<sup>20</sup>

Eight annual Virginia Commonwealth University (VCU) Life Sciences Surveys show similar results. The percentage of Americans who agreed that “developments in science helped make society better” ranged between 83% and 90% (VCU Center for Public Policy 2006 and 2008). Similarly, between 2002 and 2008 the surveys asked respondents whether they believed that “scientific research is essential for improving the quality of human lives” and found that agreement ranged between 87% and 92%. During the same period, between 88% and 92% agreed that “new technology used in medicine allows people to live longer and better.”

Figure 7-13  
Public assessment of scientific research: 1979–2008



NOTE: Includes all years for which data collected.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1979–2001); University of Michigan, Survey of Consumer Attitudes (2004); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008). See appendix tables 7-17 and 7-18.

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Americans who have more years of formal education and score higher on measures of science knowledge express more favorable attitudes about S&T. A review of numerous surveys from around the world found, other things being equal, a weak but consistent relationship between greater knowledge of science and more favorable attitudes toward science. This relationship was stronger in the United States than in any of the other countries in the study (Allum et al. 2008; for more details see NSB 2008). Optimism about science among the most interested and knowledgeable public, however, may not necessarily correspond with accurate expectations about the speed of scientific progress (see sidebar, “Public Expectations About Technological Advances”).

Although data from other countries are not entirely comparable, they appear to indicate that Americans have somewhat more positive attitudes about the benefits of S&T than Europeans, Russians, and Japanese. Attitudes in China and South Korea are comparable with the U.S., and on some questions attitudes are even more favorable, but their reservations about science are somewhat higher (appendix table 7-18). In all of the countries and regions where survey data exist, statements about the achievements and promise of science elicit substantially more agreement than disagreement.

Both in the United States and abroad, respondents also express reservations about S&T. For eight years (2001–08), VCU Life Sciences Surveys have asked respondents whether they agree that “scientific research these days doesn’t pay enough attention to the moral values of society.” Each year, a majority has agreed; however, the percentage that agreed has dropped substantially, from 73% in 2001 to 56% in 2008. In the 2008 GSS, large minorities of survey respondents registered agreement with other statements expressing reservations about science, such as “science makes our way of life change too fast” (47% agree, 51% disagree). The proportion that agrees with this statement decreases with education, family income, and factual knowledge of science (appendix table 7-20). The question has been asked in numerous other countries (appendix table 7-18). Although levels of agreement with this statement in the United States appear to be similar to those in Russia, surveys in other countries record much higher levels of agreement.<sup>21</sup>

## Federal Funding of Scientific Research

U.S. public opinion consistently and strongly supports federal spending on basic research. NSF surveys have repeatedly asked Americans whether “even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Federal Government.” Agreement with this statement has increased slightly since the early 1990s, with 84% favoring federal support in 2008 and only 12% opposing it (appendix tables 7-21 and 7-22).

Responses to a GSS question about federal spending on scientific research provide further evidence of increasing public support for federal spending on scientific research. Since 1981, the proportion of Americans who thought the

## Public Expectations About Technological Advances

In the late 1970s and early 1980s, Jon Miller surveyed Americans about the technological breakthroughs they did and did not expect in the next 25 years and looked at the differences in the expectations of three different segments of the public with regard to S&T: the attentive, the interested, and the nonattentive (Miller 1983).

The attentive public included those citizens who were at least moderately interested and knowledgeable about S&T issues and remained informed in these areas. The interested public included individuals who were interested in S&T matters and perceived themselves to be at least moderately well informed, but were not very knowledgeable and did not keep up with information in these areas. The nonattentive public had little interest in, or knowledge about, S&T issues.

The findings showed that majorities of the attentive public, and to a large extent the interested public, thought it was “very likely” that within 25 years science would

discover ways to accurately predict earthquakes, to economically desalinate seawater for human consumption, and to find more efficient cheap energy sources and a cure for common forms of cancer. In contrast, Americans who were not attentive to S&T issues leaned toward the “possible but not likely” answer (see table 7-A below).

At present seismologists can provide broad forecasts, but cannot yet accurately predict when and where earthquakes will happen. The cost of seawater desalination has become more competitive than in the past, but it is still not economically viable on a broad scale. Early detection, innovative surgery techniques, and new therapies have improved the prognosis for many types of cancers, but no cure has been found. Miller’s survey data suggest that the attentive and interested publics were more optimistic than the nonattentive, but also, in these instances, less accurate in their expectations about the speed of scientific progress.

Table 7-A

### Public expectations for future scientific achievements within next 25 years: 1979 and 1981

(Percent)

	Attentive public		Interested public		Nonattentive public	
	1979 (n = 289)	1981 (n = 637)	1979 (n = 292)	1981 (n = 617)	1979 (n = 839)	1981 (n = 1,940)
How likely do you think it is that researchers will achieve... in the next 25 years or so?						
	Percent responding “very likely”					
A way to predict when and where earthquakes will occur.....	72	63	54	63	46	NA
More efficient sources of cheap energy .....	81	74	60	65	50	NA
A cure for the common forms of cancer .....	58	59	48	61	43	NA
A way to put communities in outer space.....	28	21	18	23	13	NA
New ways of effectively reducing the crime rate.....	14	NA	17	NA	14	NA
A way to economically desalinate seawater for human consumption.....	64	63	47	63	39	NA
An economic theory to control inflation and reduce unemployment.....	NA	20	NA	28	NA	NA

NA = not available, question not asked

SOURCE: Miller JD, *The American People and Science Policy: The Role of Public Attitudes in the Policy Process*, New York: Pergamon Press, Inc. (1983).

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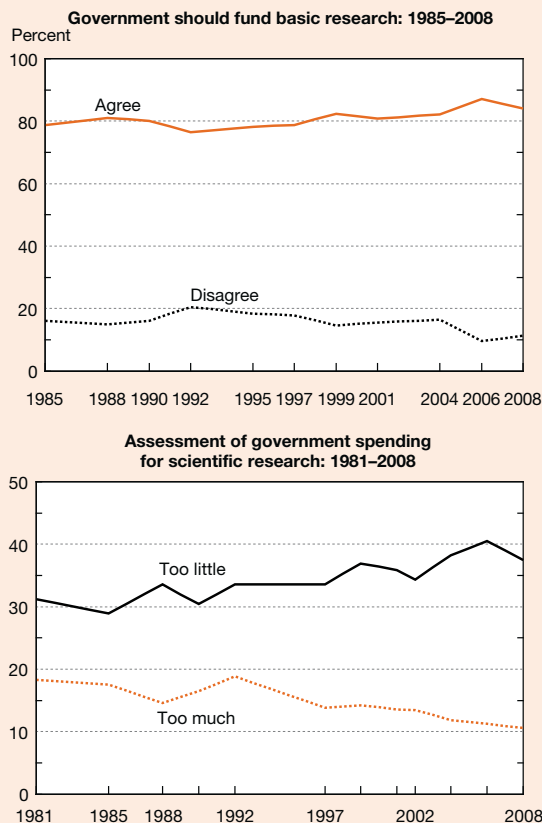
government was spending too little on scientific research has increased, fluctuating between 29% and 34% in the 1980s, between 30% and 37% in the 1990s, and between 34% and 41% since 2001. In 2006 and 2008, only about 11% said that the government was spending too much in this area, the lowest levels registered since 1981 (figure 7-14; appendix tables 7-23 and 7-24).

Although support for federal research investment is at historically high levels, other kinds of federal spending generate even stronger public support. Support for increased spending is greater in numerous program areas, including health care (75%), education (74%), assistance to the poor (69%), environmental protection (66%), social security (59%), and mass transportation (46%). Still, based on the

proportion of the U.S. population favoring increased spending, scientific research (38%) ranks well ahead of spending in national defense (24%), space exploration (14%), and assistance to foreign countries (11%).<sup>22</sup>

In other countries where similar though not precisely comparable questions have been asked, respondents also express strong support for government spending on basic scientific research. In 2005, 76% of Europeans agreed that “even if it brings no immediate benefits, scientific research which adds to knowledge should be supported by government,” and only 7% disagreed. In 2007, 74% of Chinese agreed to a similar statement. Because both the European and the Chinese survey offered a middle option (“neither agree nor disagree”), these percentages are lower than figures for the

Figure 7-14  
Public attitudes toward government funding of  
scientific research: Selected years, 1981–2008



NOTES: Top panel: survey results in 1985, 1988, 1990, 1992, 1995, 1997, 1999, 2001, 2004, 2006, and 2008; other years extrapolated. Bottom panel: survey results in 1981, 1985, 1988, 1990, 1992, 1997, 1999, 2001, 2002, 2004, 2006, and 2008; other years extrapolated.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (years through 2001); University of Michigan, Survey of Consumer Attitudes (2004 in top panel); and University of Chicago, National Opinion Research Center, General Social Survey (2006, 2008 in top panel, 2002–08 in bottom panel). See appendix table 7-21 for top panel and appendix table 7-23 for bottom panel.

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United States, where no middle category was offered (appendix table 7-21). Agreement in South Korea, Malaysia, Japan, and Brazil reaches levels comparable to those in the United States and Europe.

Support for increased government spending on scientific research is relatively common in Europe as well. Over half of Europeans agreed in 2005 that their “government should spend more money on scientific research and less on other things.” Although this proportion is nominally higher than the percentage of Americans who support more government spending, numerous context and wording differences between the questions leave responses open to substantially

differing interpretations.<sup>23</sup> Public support for increased spending on scientific research was substantially greater in South Korea (67% in 2004) than in the United States (Korea Science Foundation 2004).

## Confidence in the Science Community's Leadership

For the science-related decisions that citizens face, a comprehensive understanding of the relevant scientific research would require mastery and evaluation of a great deal of evidence. In addition to relying on direct evidence from scientific studies, citizens who want to draw on scientific evidence must consult the judgments of leaders and other experts whom they believe can speak authoritatively about the scientific knowledge that is relevant to an issue.

Public confidence in the leaders of the scientific community is one indicator of public willingness to rely on science. Since 1973, the GSS has tracked public confidence in the leadership of various institutions, including the scientific community. The GSS asks respondents whether they have “a great deal of confidence, only some confidence, or hardly any confidence at all” in the leaders of different institutions. In 2008, the percentage of Americans expressing “a great deal of confidence” in leaders of the scientific community (39%) was the same as those expressing “a great deal of confidence” in leaders of the medical community (39%) and higher than for all other institutions except the military (51%).

Conversely, the percentage expressing “hardly any confidence at all” was lower for scientific leaders than for leaders of any other institution about which this question was asked (table 7-8). Throughout the entire period in which this question has been asked, the percentage of Americans expressing a great deal of confidence in the leaders of the scientific community has fluctuated within a relatively narrow range, hovering between 35% and 45% (appendix table 7-25). In contrast, for some other institutions (e.g., the military), confidence has shown more variability over the past three decades.

Science usually ranks second or third in the public confidence surveys, with medicine or the military ranking first. The consistently high confidence in the leadership of the scientific community contrasts with a general decline in confidence in other institutional leaders over the years. The medical community, for example, has seen a long-term decline in confidence. Over half of Americans expressed a great deal of confidence in medical leaders in the mid-1970s, compared with about 40% in recent years. Thirty years ago confidence in the medical community was higher than confidence in scientific leaders. However, since 2002 science has scored as well as or better than medicine on this indicator, although the scores for the two fields remain very close.

## Influence on Public Issues

Government support for scientific research derives partly from the notion that science can support policymakers in

Table 7-8  
**Public confidence in institutional leaders: 2008**  
 (Percent)

Type of institution	Level of confidence in leaders			Don't know
	A great deal	Some	Hardly any	
Military .....	51	37	10	1
Medicine .....	39	50	11	*
Scientific community .....	39	51	6	4
U.S. Supreme Court .....	31	53	14	2
Education .....	29	54	15	1
Organized religion .....	20	53	25	2
Banks and financial institutions .....	19	60	21	1
Major companies .....	16	66	16	2
Organized labor .....	12	57	27	4
Congress .....	10	51	37	2
Executive branch of federal government .....	10	49	38	3
Television .....	9	51	39	1
Press .....	9	45	45	1

\* = <0.5% responded

NOTE: Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2008). See appendix table 7-25.

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making many public decisions. Science can play this role more effectively if the general public supports the use of scientific knowledge in such decisions and shares the view that science is relevant.

In 2006, the GSS asked about the appropriate influence of science on four public policy issues to which scientific research might be considered relevant—global climate change, research using human embryonic stem cells, federal income taxes, and genetically modified (GM) foods. Survey respondents were asked how much influence a group of scientists with relevant expertise (e.g., medical researchers, economists) should have in deciding about each issue, how well the scientists understood the issue, and to what extent the scientists would “support what is best for the country as a whole versus what serves their own narrow interests.” The same questions were asked about elected officials and either religious leaders (for stem cell research) or business leaders (for the other issues). Respondents were also asked a question about their perception of the level of consensus among the scientists regarding a largely factual aspect of the issue (e.g., “the existence and causes of global warming” or “the importance of stem cell research”) and a question that probed their attitude regarding each issue.

The GSS data indicate that Americans believe that scientists should have a relatively large amount of influence on public decisions concerning these issues (table 7-9). For the four issues, the percentage who said that scientists should have either “a great deal” or “a fair amount” of influence ranged from 85% (“global warming”) to 72% (“income taxes”). For each issue, the percentage was greater for scientists than for either of the other leadership groups. The contrast among the groups was more pronounced for the three issues

that dealt with biological or geophysical phenomena than for income taxes, where elected officials ranked closely behind economists.

Americans also give scientists relatively high marks for understanding the four issues (table 7-10). The GSS asked respondents to rate each leadership group’s understanding of a largely factual aspect of each issue on a five-point scale ranging from “very well” to “not at all.” For the three issues dealing with biological or geophysical phenomena, the differences in perceived understanding were large: between 64% and 74% of the public placed the relevant scientists in one of the top two categories, whereas only 9% to 14% placed any of the other groups in those categories. The contrast among groups was smaller for the tax issue, with economists (52%) ranking ahead of business leaders (44%) and elected officials (28%).

Patterns for the question about which groups would “support what is best for the country as a whole versus what serves their own narrow interests” were similar. For each issue, Americans placed the scientific group in one of the top two categories much more often than they placed either of the other leadership groups in those categories.

One factor that may limit the influence of scientific knowledge and the scientific community over public issues is the perception that significant scientific disagreement exists, making scientific knowledge uncertain (Krosnick et al. 2006). GSS respondents were asked to rate the degree of scientific consensus on a largely factual aspect of each of the four issues using a five-point scale ranging from “near complete agreement” to “no agreement at all.” The degree of perceived consensus of medical researchers on “the importance of stem cells for research” was the only item for

Table 7-9

**Preferred groups for influencing decisions about public issues: 2006**

(Percent)

Public issue/group	Preferred degree of influence				Don't know
	A great deal	A fair amount	A little	None at all	
Global warming					
Environmental scientists.....	47	38	7	3	4
Elected officials.....	17	33	33	13	4
Business leaders.....	10	22	38	25	5
Stem cell research					
Medical researchers.....	39	41	11	4	5
Elected officials.....	11	35	32	15	6
Religious leaders.....	8	21	36	29	6
Federal income taxes					
Economists.....	21	51	18	4	6
Elected officials.....	21	40	24	11	4
Business leaders.....	9	37	36	13	4
Genetically modified foods					
Medical researchers.....	41	40	10	3	5
Elected officials.....	7	30	37	21	5
Business leaders.....	3	16	41	35	5

NOTES: Responses to: *How much influence should each of the following groups have in deciding: global warming policy; government funding for stem cell research; reducing federal income taxes; restricting sale of genetically modified foods?* Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006). See appendix table 7-21 in National Science Board, *Science and Engineering Indicators 2008* (NSB 08-01A) (2008).

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Table 7-10

**Perceived understanding of public issues by various groups: 2006**

(Percent)

Public issue/group	Degree of understanding (on scale of 1 to 5)					Don't know
	Very well 5	4	3	2	Not at all 1	
Global warming						
Environmental scientists.....	44	22	22	4	4	4
Business leaders.....	4	8	30	32	22	4
Elected officials.....	5	7	31	29	24	4
Stem cell research						
Medical researchers.....	50	24	15	3	3	6
Religious leaders.....	6	8	26	29	25	6
Elected officials.....	3	7	35	26	22	6
Federal income taxes						
Economists.....	33	19	29	7	7	5
Business leaders.....	15	29	33	12	6	4
Elected officials.....	10	18	34	19	15	5
Genetically modified foods						
Medical researchers.....	32	32	18	8	5	6
Business leaders.....	4	7	24	31	28	6
Elected officials.....	3	6	24	33	29	5

NOTES: Responses to: *How well do the following groups understand: causes of global warming; importance of stem cell research; effects of reducing federal income taxes; risks posed by genetically modified foods?* Detail may not add to total because of rounding.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006). See appendix table 7-22 in National Science Board, *Science and Engineering Indicators 2008* (NSB 08-01A) (2008).

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which more than half of respondents (52%) chose one of the two points near the “complete agreement” end of the scale (table 7-11). In the case of the perceived consensus of environmental scientists on “the existence and causes of global warming,” 42% chose one of these two points denoting a high degree of consensus. Lower proportions of respondents chose one of these two points when asked about the extent to which medical researchers agree on “the risks and benefits of genetically modified foods” (28%) or economists on “the effects of reducing federal income taxes” (20%).

With a few exceptions, responses to these questions do not differ markedly among demographic groups. Americans with higher incomes, more education, and more science knowledge tend to have more favorable perceptions of the knowledge, impartiality, and level of agreement among scientists. For a more detailed presentation of these data and further discussion of this subject, see NSB 2008.

### What Makes an Activity Scientific

The label “scientific” is usually considered a favorable one. When research studies claim to be scientific, they claim to produce valid knowledge; when occupations claim to be scientific, they claim their practitioners have systematic expertise. It is important for the public to be able to scrutinize these claims critically and use reasonable criteria to judge them, because not all claims that an activity is scientific are equally warranted.

In 2006, the GSS included two batteries of questions that probed what characteristics Americans associate with scientific studies and what disciplines and practices Americans consider scientific. These indicators provide insight into how Americans discriminate between more and less scientific endeavors. (Data from these questions are reported in greater detail in NSB 2008.)

### Attributes That Make Something Scientific

One group of questions asked how important each of eight characteristics is in “making something scientific.” These characteristics can be divided into three groups:

- ♦ Features of the research process:
  - The conclusions are based on solid evidence.
  - The researchers carefully examine different interpretations of the results, even ones they disagree with.
  - Other scientists repeat the experiment and find similar results.
- ♦ Aspects of the credentials and institutional settings that lend credibility to the research:
  - The people who do the research have advanced degrees in their field.
  - The research is done by scientists employed in a university setting.
  - The research takes place in a laboratory.
- ♦ External validation by other belief systems:
  - The results of the research are consistent with common sense.
  - The results of the research are consistent with religious beliefs.

Americans were most likely to consider features of the research process to be very important. Over two-thirds said that “conclusions based on solid evidence” (80%), “carefully examin[ing] different interpretations of the results” (73%), and “replication of results by other scientists” (67%) were very important in making something scientific.

Americans thought that researcher qualifications were almost as important, with 62% classifying “the people who do it have advanced degrees in their field” as very important.

Table 7-11  
Perceived scientific consensus on public issues: 2006  
(Percent)

Group/public issue	Degree of consensus (on scale of 1 to 5)					Don't know
	Near complete agreement 5	4	3	2	No agreement at all 1	
Medical researchers on importance of stem cells for research .....	19	33	29	4	5	9
Environmental scientists on existence and causes of global warming.....	14	28	35	9	6	9
Medical researchers on risks and benefits of genetically modified foods .....	9	19	41	11	7	13
Economists on effects of reducing federal income taxes .....	5	15	40	14	13	13

NOTES: Responses to: *To what extent do [people in group] agree on [public issue]? Detail may not add to total because of rounding.*

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006). See appendix table 7-24, National Science Board, *Science and Engineering Indicators 2008* (NSB 08-01A) (2008).

Institutional settings often associated with research, such as laboratories (41%) and universities (33%), ranked lower. Respondents viewed these settings as similar in importance to having results that were “consistent with common sense.” Most Americans viewed consistency with religion as either not at all important (39%) or not too important (31%) to making something scientific.

Response patterns for this group of questions are related to the respondent’s education level (figure 7-15). Although Americans at all levels of education rated research process characteristics as most important, more highly educated Americans gave these characteristics the highest ratings. In contrast, individual credentials, institutional auspices, and consistency with other beliefs were seen as less important among more highly educated respondents than among others. As a result of these divergent patterns, the gap in importance between process characteristics and other attributes is wide at higher levels of education but relatively narrow for people with less schooling (figure 7-15). (For more details, see NSB 2008.)

### Which Fields Are Scientific

The 2006 GSS asked Americans about eight fields of research or practice and whether they were “very scientific, pretty scientific, not too scientific, or not scientific at all.”

Practically all Americans (98%) perceived medicine as “very” or “pretty” scientific, even though it is focused more on practical service delivery and less on research than other listed fields, including biology and physics. Nonetheless, both of these disciplines were also overwhelmingly seen as either “very” or “pretty” scientific (94% for biology and 90% for physics). Americans with more years of education and more classroom exposure to science and mathematics were more likely to believe that these two fields were relatively scientific, particularly physics.

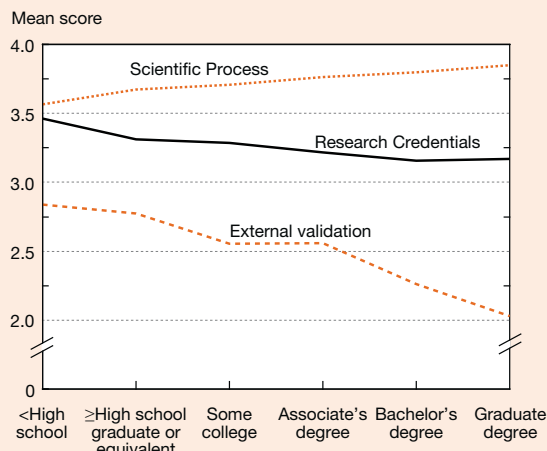
Engineering, a discipline which like medicine involves the application of science and mathematics to develop solutions to practical problems, ranked below the other three fields on this measure; 77% perceived engineering as “very” or “pretty” scientific.

About 50% of Americans said that the two social science disciplines on the list (economics and sociology) were “very” or “pretty” scientific. Accounting and history were less likely to be placed at the scientific end of the scale; respondents with less education were more likely than others to classify history as relatively scientific. A similar question on the 2005 Eurobarometer about an overlapping set of fields produced generally similar results (EC 2005).

### Views of S&E Occupations

Data on public esteem for S&E occupations are an indicator of the attractiveness of these occupations and their ability to recruit talented people into their ranks. Such data may also have a bearing on the public’s sense that S&E affects the nation’s well-being in the future.

**Figure 7-15**  
Importance of scientific process, research credentials, and external validation to public’s belief that something is scientific, by education level: 2006



NOTES: Responses to how important each of eight statements is to making something scientific—very important, pretty important, not too important, not important at all (where 4 = very important and 1 = not important at all). Mean importance scores for process, credentials, and external validation are computed averages of responses to all statements in category. Process statements: (1) *The conclusions are based on solid evidence*; (2) *The researchers carefully examine different interpretations of the results, even ones they disagree with*; (3) *Other scientists repeat the experiment, and find similar results*. Credentials statements: (1) *The people who do it have advanced degrees in their field*; (2) *It is done by scientists employed in a university setting*; (3) *The research takes place in a laboratory*. External validation statements: (1) *The results of the research are consistent with common sense*; (2) *The results of the research are consistent with religious beliefs*.

SOURCE: University of Chicago, National Opinion Research Center, General Social Survey (2006). See appendix tables 7-25 and 7-26 in National Science Board, *Science and Engineering Indicators 2008* (NSB 08-01A) (2008).

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For over 30 years, the Harris Poll (Harris Interactive 2008b) has asked about the prestige of a large number of occupations, including scientists and engineers (table 7-12). In 2008, 56% of Americans said that scientists had “very great prestige,” and 40% expressed this view about engineers. Most occupations in the surveys ranked well below engineers.<sup>24</sup>

Between 1977 and 2008, the percentage of survey respondents attributing “very great prestige” to scientists has fluctuated between 51% and 66%. There has not been a clear trend over the years. The comparable score for engineers increased from 30% in 2007 to 40% in 2008, the highest level in thirteen surveys since the question was first asked in 1977.

Scientists ranked higher in prestige than almost all occupations in the Harris surveys. In recent years, their ranking was comparable with that of nurses, doctors, firefighters, and teachers and ahead of military and police officers. Engineers’ standing is high and comparable to occupations

Table 7-12  
**Prestige of various occupations: Selected years, 1977–2008**  
 (Percent)

Occupation	1977	1982	1992	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Firefighter .....	NA	NA	NA	NA	NA	NA	NA	NA	55	48	56	63	61	57
Scientist.....	66	59	57	51	55	56	53	51	57	52	56	54	54	56
Doctor.....	61	55	50	52	61	61	61	50	52	52	54	58	52	53
Nurse.....	NA	NA	NA	NA	NA	NA	NA	NA	47	44	50	55	50	52
Teacher.....	29	28	41	49	53	53	54	47	49	48	47	52	54	52
Military officer.....	NA	22	32	29	34	42	40	47	46	47	49	51	52	46
Police officer.....	NA	NA	34	36	41	38	37	40	42	40	40	43	46	46
Farmer.....	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	36	41	41
Priest/minister/clergy.....	41	42	38	45	46	45	43	36	38	32	36	40	42	40
Engineer.....	34	30	37	32	34	32	36	34	28	29	34	34	30	40
Member of Congress.....	NA	NA	24	23	25	33	24	27	30	31	26	28	26	28
Architect.....	NA	NA	NA	NA	26	26	28	27	24	20	27	27	23	28
Lawyer.....	36	30	25	19	23	21	18	15	17	17	18	21	22	24
Athlete.....	26	20	18	21	20	21	22	21	17	21	23	23	16	20
Journalist.....	17	16	15	15	15	16	18	19	15	14	14	16	13	18
Union leader.....	NA	NA	12	14	16	16	17	14	15	16	15	12	13	18
Business executive.....	18	16	19	16	18	15	12	18	18	19	15	11	14	17
Actor.....	NA	NA	NA	NA	NA	NA	NA	NA	13	16	16	12	9	16
Entertainer.....	18	16	17	18	19	21	20	19	17	16	18	18	12	15
Accountant.....	NA	13	14	18	17	14	15	13	15	10	13	17	11	15
Banker.....	17	17	17	15	18	15	16	15	14	15	15	17	10	15
Stockbroker.....	NA	NA	NA	NA	NA	NA	NA	NA	8	10	8	11	12	10
Real estate agent/broker.....	NA	NA	NA	NA	NA	NA	NA	NA	6	5	9	6	5	6

NA = not available, question not asked

NOTES: Responses to *I am going to read off a number of different occupations. For each, would you tell me if you feel it is an occupation of very great prestige, considerable prestige, some prestige, or hardly any prestige at all?* Data reflect responses of “very great prestige.”

SOURCE: Prestige Paradox: High Pay Doesn't Necessarily Equal High Prestige: Teachers' Prestige Increases the Most Over 30 Years, Harris Poll, Harris Interactive (5 August 2008), [http://www.harrisinteractive.com/harris\\_poll/index.asp?PID=939](http://www.harrisinteractive.com/harris_poll/index.asp?PID=939), accessed 22 September 2009.

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clustered just below the top group (including clergy, military officers, and police officers).

Prestige appears to reflect perceived service orientation and public benefit more than high income or celebrity; for instance, the proportions of respondents who attributed “very great prestige” to entertainers or actors were 15% and 16%, respectively (table 7-12). Americans are more likely to trust people in prestigious occupations (including scientists) to tell the truth (Harris Interactive 2006).

Some evidence suggests that Americans rate scientific careers more positively than is the case in at least some other countries. In 2004, a little over 50% of South Koreans said they would feel happy if their son or daughter wanted to become a scientist. Among Chinese, science (40%) ranked close to medicine (41%) and teaching (43%) as an occupation that survey respondents hoped their children will pursue (CRISP 2008). In the United States, 80% of those surveyed in 2001 expressed positive views regarding their children becoming scientists.

In 2006, the majority of Israelis said they would be pleased if their children became scientists (77%), engineers (78%), or physicians (78%) (Yaar 2006).

## Public Attitudes About Specific S&T-Related Issues

Public attitudes can affect the speed and direction of S&T development. When science plays a substantial role in a national policy controversy, more than the specific policies under debate may be at stake. The policy debate may also shape public opinion and government decisions about investments in general categories of research. Less directly, a highly visible debate involving science may shape overall public impressions of either the credibility of science or the proper role of science in other, less visible public decisions.

Likewise, public attitudes about emerging areas of research and new technologies may have an impact on innovation. The climate of opinion concerning new research areas could influence levels of public and private investment in related technological innovations and, eventually, the adoption of new technologies and the growth of industries based on these technologies.

For these reasons, survey responses about policy controversies involving science, specific research areas, and emerging technologies are relevant. In addition, responses about relatively specific matters provide a window into the

practical decisions through which citizens translate more general attitudes into actions, although, like all survey responses, how these responses relate to actual behavior remains uncertain. More generally, even in democratic societies, public opinion about new scientific and technological developments does not translate directly into actions or policy. Instead, it filters through institutions that selectively measure what the public believes and either magnify or minimize the effects of divisions in public opinion on public discourse and government policy (Jasanoff 2005).

Attitudes toward policy issues always involve a multitude of factors and not just knowledge or understanding of relevant science. Values, morals, judgments of prudence, and numerous other factors can come strongly into play. Judgments about scientific fact are often secondary. In assessing the same issue, different people may find different considerations relevant.

This section begins with data on environmental issues, including global climate change and nuclear power. It then covers attitudes toward recent and novel technologies, including medical biotechnology, agricultural biotechnology (i.e., GM food), and nanotechnology. Data on cloning and stem cell research follow, and the section concludes with recent data on attitudes toward science and mathematics education and toward scientific research on animals.

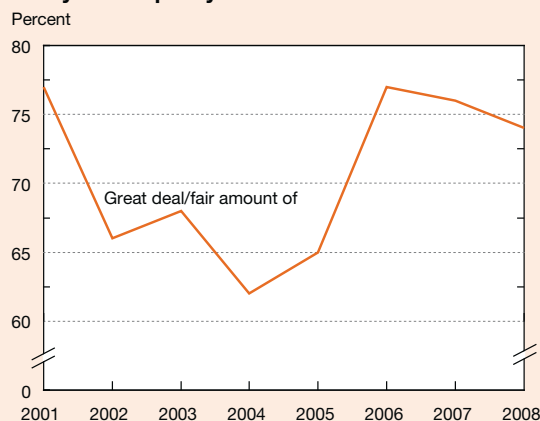
## Environment and Climate Change

The Gallup Organization's annual survey on environmental issues indicates that Americans have become somewhat more concerned about environmental quality in the last 4 years (figure 7-16). Between 2004 and 2008, the percentage of Americans expressing "a great deal" or "a fair amount" of worry about the "quality of the environment" rose from 62% to 74%, returning approximately to its 2001 level (Saad 2008b).

Despite the rise in "worry" about the environment, concern about this issue barely registers when surveys ask Americans to name the country's top problem. In surveys conducted in the first quarter of 2009, only about 2% of Americans mentioned the environment or pollution in an open-ended question asking "What do you think is the most important problem facing this country today?" (The Gallup Organization 2009a, 2009b). In close-ended questions, worry about the environment ranked lower than worry about the economy (90%), the availability and affordability of either energy (82%) or healthcare (81%), and crime and violence (80%). The proportion of Americans worried about the quality of the environment was similar to the proportion worried about Social Security (75%), future terrorist attacks (73%), and hunger and homelessness (73%) and higher than the percentage worried about illegal immigration (70%), unemployment (68%), drug use (67%), and race relations (45%).

In the 2008 GSS, the majority of Americans (66%) believed that the government is spending too little to reduce pollution and only a handful thought it spent too much (8%, appendix table 7-23). The proportion who believed that the

**Figure 7-16**  
**Worry about quality of environment: 2001–08**



NOTES: Poll conducted annually in March. Survey asked Americans how much they worry about the quality of the environment and other domestic issues. Figure combines percentage saying they worry "a great deal" and "a fair amount."

SOURCES: Saad L, Economic Anxiety Surges in Past Year, The Gallup Poll (28 March 2008), <http://www.gallup.com/poll/105802/Economic-Anxiety-Surges-Past-Year.aspx>, accessed 23 September 2009. Saad L, Americans See Environment Getting Worse, The Gallup Poll (20 April 2006) <http://www.gallup.com/poll/224711/Americans-See-Environment-Getting-Worse.aspx>, accessed 3 June 2009.

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government is spending too little in this policy area has fluctuated between 60% and 67% since 1997 and is still lower than it was in 1988 and 1990 (76% for both years). The trend in support for environmental protection was less evident when Americans were asked about tradeoffs between environmental protection and economic growth (figure 7-17). In March 2009, only 42% of Americans indicated that the protection of the environment should take precedence over economic growth (down from about 70% in 1990–91 and in 2000).

However, when asked about various proposals to protect the environment in Gallup surveys conducted between 2001 and 2007 (table 7-13), strong majorities endorsed government spending to develop alternate sources of fuel for automobiles and to develop solar and wind power. Majorities also favored different environmentally friendly measures such as setting higher emissions and pollution standards for business and industry and enforcing federal environmental regulations more strongly. Lower proportions favored expanding the use of nuclear energy and opening up the Arctic National Wildlife Refuge in Alaska for oil exploration (The Gallup Organization 2009a).

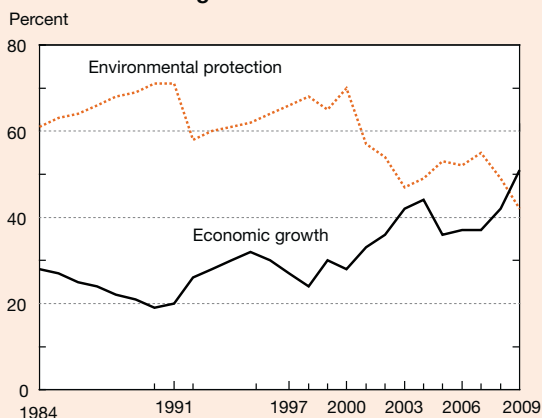
National data on the use of biofuels for energy consumption is scarce, but one survey found that 70% of Americans thought using ethanol was "mostly a good idea" (Broder and Connelly 2007).

Climate change, sometimes referred to as global warming (see sidebar "'Climate Change' Versus 'Global Warming'"),

has recently become more prominent among environmental issues for the American public. Since 2000, Gallup has asked Americans how much they personally worry about eight environmental issues. The percentage of Americans who said they worried “a great deal” about “global warming” decreased from 40% in 2000 to 26% in 2004, but increased to 34% in 2008 (Saad 2009). Even with this increase, “global warming” still ranked eighth among these issues. The percentage of Americans worrying “a great deal”

about this issue was lower than the percentage of Americans worrying “a great deal” about water-related environmental issues such as “pollution of drinking water” (59%), “pollution of rivers, lakes, and reservoirs” (52%), “contamination of soil and water by toxic waste” (52%), “maintenance of the

**Figure 7-17**  
**Public priorities for environmental protection versus economic growth: 1984–2009**



NOTES: Responses to *With which one of these statements about the environment and the economy do you most agree—protection of the environment should be given priority, even at the risk of curbing economic growth (or) economic growth should be given priority, even if the environment suffers to some extent?* Poll conducted in 1984, 1990–92, 1995, 1997–2009; other years extrapolated.

SOURCE: Newport F, *Americans: Economy Takes Precedence Over Environment* (19 March 2009), <http://www.gallup.com/poll/116962/Americans-Economy-Takes-Precedence-Over-Environment.aspx?version=print>, accessed 23 September 2009.

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## “Climate Change” Versus “Global Warming”

The terms “climate change” and “global warming” are often used interchangeably. Scientists increasingly prefer the term “climate change,” which conveys the idea that more than a rise in temperatures is occurring (National Academies 2008b). However, most survey data registers opinion about global warming, not about climate change.

Limited research in the United States and Europe suggests that variations in terminology do not significantly affect survey responses on this issue. A large sample of voluntary survey respondents in the United States, randomly divided into two groups, was asked “If nothing is done to reduce climate change/global warming in the future, how serious a problem do you think it will be?” The two groups responded similarly, regardless of which term was used (Villar and Krosnick 2009).

Two similar European experiments also showed that the two terms made little or no difference in perceptions of the problem. In one, respondents were asked to identify “the most serious problem currently facing the world as a whole” from a list that included either “global warming” or “climate change.” In the other, the choice of term did not affect how Europeans rated the seriousness of the problem “at this moment” (EC 2008b).

**Table 7-13**  
**Public approval of specific environmental proposals: 2001–07**  
(Percent)

Environmental proposal	2001	2002	2003	2006	2007
Spending government money to develop alternate sources of fuel for automobiles .....	NA	NA	NA	85	86
Setting higher emissions and pollution standards for business and industry .....	81	83	80	77	84
More strongly enforcing federal environmental regulations .....	77	78	75	79	82
Spending more government money on developing solar and wind power.....	79	NA	NA	77	81
Setting higher auto emissions standards for automobiles.....	75	72	73	73	79
Imposing mandatory controls on carbon dioxide emissions and other greenhouse gases.....	NA	NA	75	75	79
Expanding use of nuclear energy .....	44	45	43	55	50
Opening Arctic National Wildlife Refuge in Alaska for oil exploration .....	40	40	41	49	41

NA = not available, question not asked

NOTES: Responses to: *I am going to read some specific environmental proposals. For each one, please say whether you generally favor or oppose it. How about...?* Data reflect responses of “favor.” Table includes all years for which data collected; question asked in March of each year.

SOURCE: Gallup’s Pulse of Democracy: The Environment, <http://www.gallup.com/poll/1615/Environment.aspx>, accessed 22 September 2009.

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nation's fresh water supply for household needs" (49%), and also "air pollution" (45%). Response categories in surveys, however, are not always distinct and may evoke overlapping associations in respondents. "Air pollution," for example, is related to carbon emissions and climate change.

Recent data show additional signs that awareness of climate change is increasing. Since 2004, Gallup surveys registered gradual increases in the percentage of Americans who say they understand the "global warming" issue "very well" or "fairly well," from 68% in 2004 to 80% in 2008 (The Gallup Organization 2009a). In addition, the number of Americans who say that the effects of "global warming" have already begun to occur has been steadily increasing since 2004 and was at an all time high in 2008 at 61%. The percentage of Americans who believe that most scientists think "global warming" is occurring has also been rising for over a decade. Most Americans think that "the increases in the Earth's temperature over the last century" are largely the result of human activities rather than natural changes; that percentage has been stable since 2001, hovering between 58% and 61% (The Gallup Organization 2009a).

## Nuclear Power

In the debate over America's sources of energy, nuclear power has been a controversial subject. On the one hand, nuclear power is an appealing option to meet energy needs due to its low emissions of greenhouse gases and other atmospheric pollutants. On the other hand, there are serious concerns about this technology, such as risks in the operation of nuclear plants, the disposal of nuclear waste, and nuclear proliferation.

Overall, support for nuclear power is lower than for conservation-based energy strategies (table 7-13), but it has grown in the last 2 years. American public opinion has been fairly evenly divided since the mid-1990s, but the proportion of Americans who favor the use of nuclear power as one of the ways to provide electricity for the U.S. increased from 53% in 2007 to 59% in 2009 (Jones 2009). A substantial minority of Americans (42%) thinks nuclear power plants are not safe and prior surveys indicate that three out of five Americans oppose the construction of a nuclear energy plant in their local communities.<sup>25</sup>

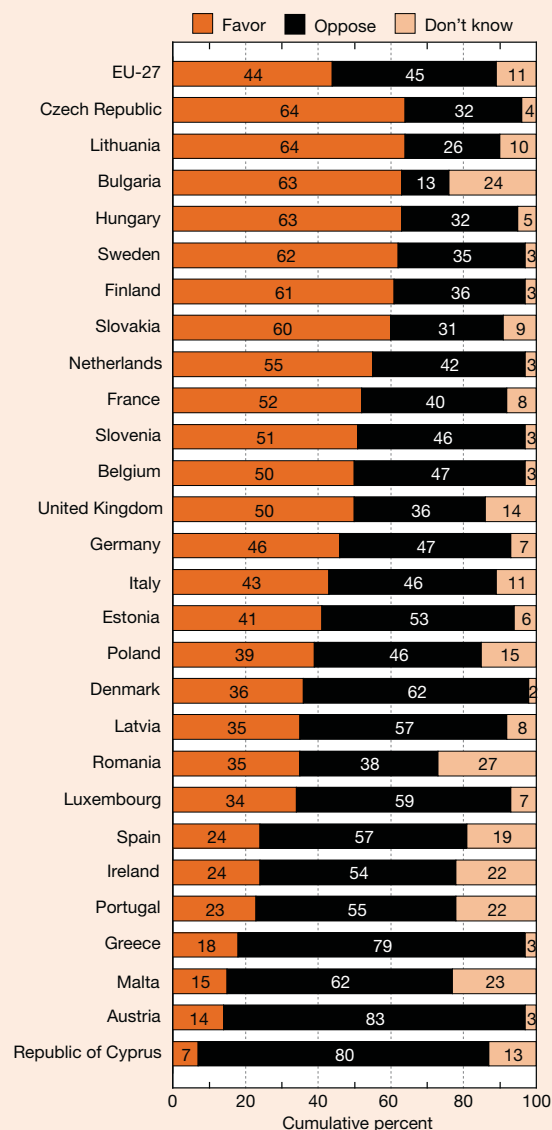
Despite some differences in wording between the Eurobarometer and the U.S. questions, a 2008 report shows that European public opinion on nuclear energy is divided but support for energy production by nuclear power stations has grown since 2005 (EC 2008a). Support for nuclear energy varies a great deal among countries in this region. In general, citizens of countries that have operational nuclear power plants are considerably more likely to support nuclear energy than citizens of other countries (figure 7-18).<sup>26</sup>

## Biotechnology and Its Medical Applications

Recent advances in recombinant DNA technology enable the manipulation of genetic material to produce plants and animals with desirable characteristics. The most recent

American data on attitudes in this area are from 2005. They show that Americans, Canadians, and Europeans have similarly favorable attitudes toward biotechnology in general and medical applications in particular. A study that collected U.S. and Canadian data found that about two-thirds

Figure 7-18  
European attitudes towards energy production by nuclear power: 2008



NOTES: Responses to *Are you in favor, fairly in favor, fairly opposed, or totally opposed to energy production by nuclear power stations?*

SOURCE: European Commission, Research Directorate-General for Energy and Transport, Special Eurobarometer 297/Wave 69.1, Attitudes Towards Radioactive Waste, Table QB2 (2008). Fieldwork completed 18 February–22 March 2008, [http://ec.europa.eu/public\\_opinion/archives/ebs/ebs\\_297\\_en.pdf](http://ec.europa.eu/public_opinion/archives/ebs/ebs_297_en.pdf), accessed 3 June 2009.

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of survey respondents in each country registered favorable attitudes (Canadian Biotechnology Secretariat 2005).<sup>27</sup>

Few Americans (about 1 in 10) consider themselves “very familiar” with biotechnology and Canadians report slightly less familiarity. Without a strong knowledge base to use in evaluating information, their assessment of the credibility of information sources is an important element in forming their judgments about information on this topic. In both the United States and Canada, scientific journals and government-funded scientists were the top-rated institutions that could provide information about biotechnology. Conversely, privately owned mass media, biotechnology company executives, and religious and political leaders ranked near the bottom in both countries. (For more detail on this subject, see NSB 2008.)

### Genetically Modified Food

Although the introduction of GM crops has provoked much less controversy in the United States than in Europe, U.S. popular support for this application of biotechnology is limited. According to a 2008 CBS/*New York Times* poll, 44% of Americans indicated they had not heard much about GM ingredients added to foods to make them taste better and last longer. However, 87% believed that these foods should be labeled and 53% expected that it was “not very likely” or “not at all likely” that they would buy food that was labeled as such.

Overall, these results are consistent with a series of five surveys conducted by the Pew Initiative on Food and Biotechnology between 2001 and 2006. These studies consistently found that only about one-fourth of U.S. consumers favored “the introduction of genetically modified foods into the U.S. food supply” (Mellman Group, Inc. 2006). The proportion of U.S. survey respondents reporting a negative reaction to the phrase “genetically modified food” (44%) was more than twice the 20% that reported a positive reaction (Canadian Biotechnology Secretariat 2005). Nonetheless, consumers in the United States expressed more favorable views than Europeans, with Canadians falling somewhere in between (Gaskell et al. 2006).

Although the FDA proposed guidelines for the approval process for genetically engineered animals in September 2008 (Maugh and Kaplan 2008), past surveys have generally found that in the U.S. residents are even more wary of genetic modification of animals than they are of genetic modification of plants (Mellman Group, Inc. 2005). Many express support for regulatory responses, but this support appears to be quite sensitive to the way issues are framed. Thus, whereas 29% expressed a great deal of confidence in “the Food and Drug Administration or FDA,” only about half as many expressed the same confidence when the question was posed about “government regulators” (Mellman Group, Inc. 2006). (Additional findings from earlier U.S. surveys can be found in NSB 2006 and NSB 2008.)

### Nanotechnology

Nanotechnology involves manipulating matter at unprecedentedly small scales to create new or improved products that can be used in a wide variety of ways. Nanotechnology has been the focus of relatively large public and private investments for almost a decade, and innovations based on nanotechnology are increasingly common. However, relative to other new technologies, nanotechnology is still in an early stage of development and the degree of risk remains uncertain (Chatterjee 2008, Barlow et al. 2009).

Data from the 2008 GSS indicated that overall familiarity with nanotechnology is similar to its 2006 level. The proportion of Americans who had heard “a lot” or “some” about nanotechnology remained virtually unchanged (5% and 15% in both 2006 and 2008), but the proportion of those who had heard “a little” or “nothing at all” declined slightly (appendix table 7-26). These numbers are similar to those reported by the Project on Emerging Nanotechnologies based on a national survey conducted in August 2008 (Peter D. Hart Research Associates 2008). While the questions asked are not strictly comparable, familiarity with nanotechnology in the 2006 GSS was similar to that in Europe in 2005, in which 44% of survey respondents said they had heard of it (Gaskell et al. 2006).

Despite increased federal funding and more than 600 nanotechnology products already on the market (The National Academies 2008a),<sup>28</sup> nanotechnology knowledge levels were not high (appendix table 7-11) and remained similar to 2006, even among the minority of GSS respondents who had heard of nanotechnology. In 2008, 63% of the respondents who had heard at least a little about this technology correctly indicated that the statement “nanotechnology involves manipulating extremely small units of matter, such as individual atoms, in order to produce better materials” was true, but many (29%) said they did not know, and a few (8%) thought this statement was false. Almost half (47%) did not know whether the statement “the properties of nanoscale materials often differ fundamentally and unexpectedly from the properties of the same materials at larger scales” was true, while 41% correctly answered true and the remaining 12% answered false. A third of the respondents answered both questions correctly.

When nanotechnology is defined in surveys, Americans express favorable expectations for it. After receiving a brief explanation of nanotechnology, GSS respondents were asked about the likely balance between the benefits and harms of nanotechnology. Similar to 2006, in 2008 38% said the “benefits will outweigh the harmful results” and only 9% expected the harms to predominate (appendix table 7-27). In 2008, however, the proportion of Americans who said they did not know whether the benefits of nanotechnology would outweigh the harmful results or vice versa increased, and the proportion who expected the benefits to be equal to the harmful results decreased. The fact that about half of respondents either gave a neutral response (12%) or said they did not know (40%) suggests that these opinions

are open to change as Americans become more familiar with this technology.

Favorable expectations for nanotechnology are associated with more education, greater science knowledge, and greater familiarity with nanotechnology. Men are also more likely to have favorable expectations than women (appendix table 7-27). In these aspects, patterns are similar to those for responses concerning S&T in general.

In the GSS data, favorable attitudes toward nanotechnology are also associated with greater familiarity with it. That is, Americans who say they are more familiar with nanotechnology are more likely to believe that its benefits will outweigh the risks. However, this association does not mean that when people become more familiar their attitudes necessarily become positive. Some data suggest that when individuals who report knowing little or nothing about nanotechnology hear a balanced statement of its risks and benefits, they develop less favorable opinions of it (Peter D. Hart Research Associates, Inc. 2008). Furthermore, recent research suggests that attitudes toward nanotechnology are likely to vary depending on the context in which it is applied, with energy applications viewed much more positively than those in health and human enhancements (Pidgeon et al. 2009).

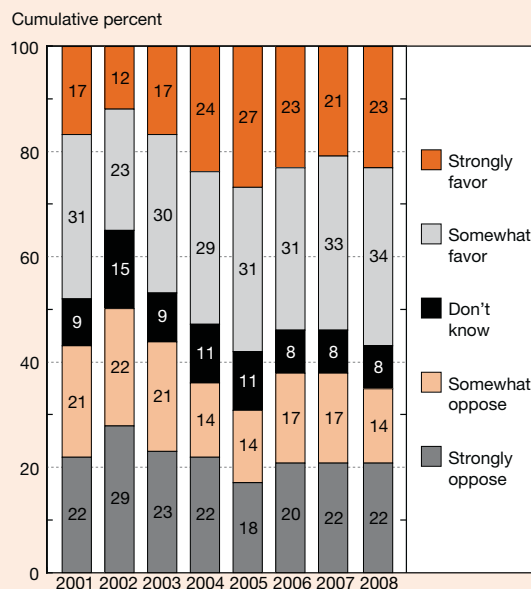
### Stem Cell Research and Human Cloning

Unlike most issues involving scientific research, studies using embryonic stem cells have generated considerable public controversy. In the case of stem cell research, strongly held views about moral fundamentals determine many people's attitudes. There is less reason to believe that this is the case for certain other S&T issues, such as nuclear power.

Although a majority of the public supports such research, a substantial minority is opposed to it. When surveys ask about medical technologies that could be derived from embryonic stem cell research in the context of expected health benefits, public response is relatively positive. But technologies that involve cloning human embryos evoke consistently strong and negative responses.

Since 2004, the majority of the American public has favored "medical research that uses stem cells from human embryos" (VCU Center for Public Policy 2008). Support grew continuously from 2002 (35% in favor) to 2005 (58% in favor) and remained at a similar level in 2008 (figure 7-19). In eight annual Gallup surveys between 2002 and 2009, the percentage of Americans who found such research "morally acceptable" ranged from 52% to 64%, and the percentage saying it was "morally wrong" from 30% to 39% (Saad 2008a; The Gallup Organization 2009c). Similarly, in five Pew surveys conducted between August 2004 and August 2007, a consistent but slim majority agreed that it was "more important to continue stem cell research that might produce new medical cures than to avoid destroying the human embryos used in the research" while about a third said not destroying embryos was more important (Pew Forum on Religion and Public Life 2008).

Figure 7-19  
Public attitudes toward stem cell research:  
2001-08



NOTES: Responses to *On the whole, how much do you favor or oppose medical research that uses stem cells from human embryos?* Most recent question asked 24 November–7 December 2008.

SOURCE: Virginia Commonwealth University (VCU), VCU Center for Public Policy, VCU Life Sciences Survey (2008), [http://www.vcu.edu/lifesci/centers/cen\\_lse\\_surveys.html](http://www.vcu.edu/lifesci/centers/cen_lse_surveys.html), accessed 23 September 2009.

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Support for stem cell research is higher when the question inquires about research that uses stem cells from sources that do not involve human embryos. Seven out of ten respondents favored this type of research in 2008, down slightly from 75% in 2007 (VCU Center for Public Policy 2008). Support also increased when the question was framed as an emotionally compelling personal issue ("If you or a member of your family had a condition such as Parkinson's Disease, or a spinal cord injury, would you support the use of embryonic stem cells in order to pursue a treatment for that condition?"). In this case, 70% of Americans support treatments that use stem cells and only 21% do not (VCU Center for Public Policy 2006). Responses become more mixed when questions mention "cloning technology" that is used only to help medical research develop new treatments for disease. However, opinion is decidedly negative when the question asks about cloning or genetically altering animals without mention of a medical purpose (table 7-14).

Americans are overwhelmingly opposed to human cloning. In a 2008 VCU survey, the idea of cloning or genetically altering humans was rejected by 78% of Americans (VCU Center for Public Policy 2008). The specter of reproductive cloning can generate apprehension about therapeutic cloning. Asked how concerned they were that "the use of

human cloning technology to create stem cells for human therapeutic purposes will lead to a greater chance of human reproductive cloning,” over two-thirds of Americans said they were either very (31%) or somewhat (37%) concerned (VCU Center for Public Policy 2006).

In 2008, about two-thirds of Americans were “very clear” (23%) or “somewhat clear” (41%) about the difference between stem cells that come from human embryos, stem cells that come from adults, and stem cells that come from other sources (VCU Center for Public Policy 2008). However, public attitudes toward cloning technology are not grounded in a strong grasp of the difference between reproductive and therapeutic cloning (see glossary for the definitions). Most Americans (64%) said they were not clear (“not very clear” or “not clear at all”) about this distinction, with 26% saying they were “somewhat clear” and only 8% characterizing themselves as “very clear” about it. The number of Americans who professed greater comprehension in 2008 was lower than it was when VCU began asking this question in 2002, despite, or perhaps because of, the increased visibility of stem cell research as a public issue.

Support for stem cell research is strongest among people with more years of formal education. Americans who are more religious and more politically conservative are more likely to oppose such research (VCU Center for Public Policy 2008).

A recent international survey on attitudes toward stem cell research in a dozen European countries, the United States, Japan, and Israel found that awareness, knowledge, and attitudes about this type of research vary widely (Fundacion BBVA 2008). Overall, Americans are more aware of stem cell research than residents of most other countries and more often respond correctly to knowledge questions on this subject. Americans are somewhat more likely than

residents of several countries in Europe to believe that stem cell research is immoral (appendix table 7-28).

## Science and Mathematics Education

In much public discourse about how Americans will fare in an increasingly S&T-driven world, quality education in science and mathematics is seen as crucial for both individuals and the nation as a whole.

In the 2008 GSS, majorities of Americans in all demographic groups agreed that the quality of science and mathematics education in American schools is inadequate. Their level of agreement increases with education, science knowledge, income, and age (appendix table 7-29). Dissatisfaction with the quality of math and science education increased from 63% in 1985 to 70% in 2008, but is still below its peak in 1992 (75%) (figure 7-20; appendix table 7-30).

In addition, the proportion of Americans who indicated they believe the government is spending too little money in improving education in the biannual GSS surveys has been consistently over 70% since the early 1980s. Along with improving health care, this is one of the two top areas where the public feels government spending is too low (figure 7-20, appendix table 7-23).

## Scientific Research on Animals

The medical research community conducts experimental tests on animals in order to advance scientific understanding of biological processes and test the effectiveness of drugs and procedures that may eventually be used to improve human health.

Most Americans support at least some kinds of animal research. Nearly two-thirds said they favored “using animals in medical research” (VCU Center for Public Policy

Table 7-14

### Public opinion on medical technologies derived from stem cell research: Most recent year

(Percent)

Question	Favor	Oppose
1. If you or a member of your family had a condition such as Parkinson's Disease, or a spinal cord injury, would you support the use of embryonic stem cells in order to pursue a treatment for that condition? (Yes or no).....	70	21
2. Do you favor or oppose medical research that uses stem cells from sources that do NOT involve human embryos? (Strongly favor, somewhat favor, somewhat oppose, strongly oppose).....	70	22
3. Do you favor or oppose using human cloning technology IF it is used ONLY to help medical research develop new treatments for disease? (Strongly favor, somewhat favor, somewhat oppose, or strongly oppose).....	52	45
4. The technology now exists to clone or genetically alter animals. How much do you favor or oppose allowing the same thing to be done in humans? (Strongly favor, somewhat favor, somewhat oppose, or strongly oppose).....	17	78

NOTES: Question 1 asked 7–21 November 2006. Questions 2, 3, 4 asked 24 November–7 December 2008. Detail does not add to total because “don't know” responses not shown.

SOURCE: Virginia Commonwealth University (VCU), Center for Public Policy, VCU Life Sciences Survey (question 1, 2006; questions 2, 3, 4, 2008), [http://www.vcu.edu/lifesci/centers/cen\\_lse\\_surveys.html](http://www.vcu.edu/lifesci/centers/cen_lse_surveys.html), accessed 22 September 2009.

2007). According to a different survey conducted by Gallup, the majority of respondents supported this kind of research: 64% opposed “banning all medical research on laboratory animals” and 59% opposed “banning all product testing on laboratory animals” (Newport 2008).

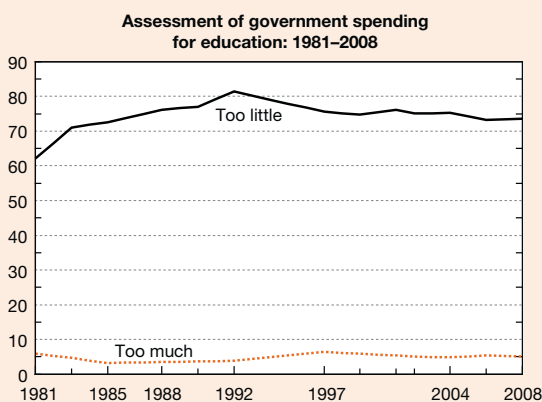
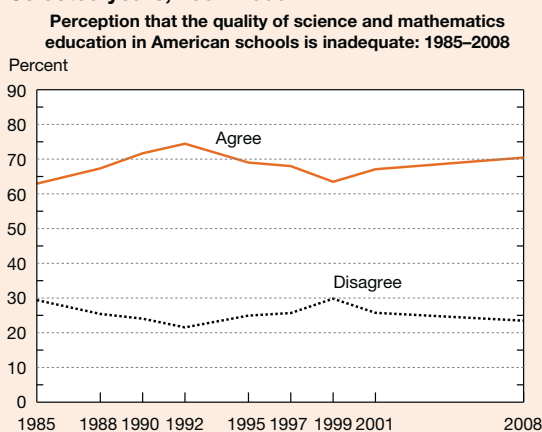
However, opposition has grown in the past two decades. When asked whether scientists should be allowed to do “research that causes pain and injury to animals like dogs and chimpanzees” if it produces new information about human health problems, between 42% and 45% of Americans in the early 1990s disagreed. This proportion increased to 51% in

2001 and 58% in 2008 (figure 7-21, appendix tables 7-31 and 7-32).<sup>29</sup> Annual surveys conducted by Gallup since 2001 show a similar pattern. While a majority of Americans say that “medical testing on animals is morally acceptable,” this percentage decreased from 65% in 2001 to 56% in 2008 (Saad 2008a). Men are more likely than women to approve this kind of research (appendix table 7-31).

Past NSF surveys suggest that the public is more comfortable with the use of mice in scientific experiments than the use of dogs and chimpanzees (NSB 2002). In 2001 68% of Americans agreed that scientists should be allowed to do research that causes pain and injury to animals like mice if it produces new information about human health problems, compared to 44% who expressed agreement when the question focused on dogs and chimpanzees (NSB 2002).

While recent comparable international data are lacking, a survey conducted by Gallup in 2003 showed that Americans and Canadians were more likely to tolerate scientific research on animals than the British. When asked: “Regardless of whether or not you think it should be legal, please tell me whether you personally believe that in general medical testing on animals is morally acceptable or morally wrong,” the majority of adults in the U.S. and Canada believed it was morally acceptable (63% and 59%, respectively). In contrast, the majority of British respondents thought it was morally wrong (54%) (Mason Kiefer 2003).

**Figure 7-20**  
**Public attitudes toward education in America:**  
**Selected years, 1981–2008**

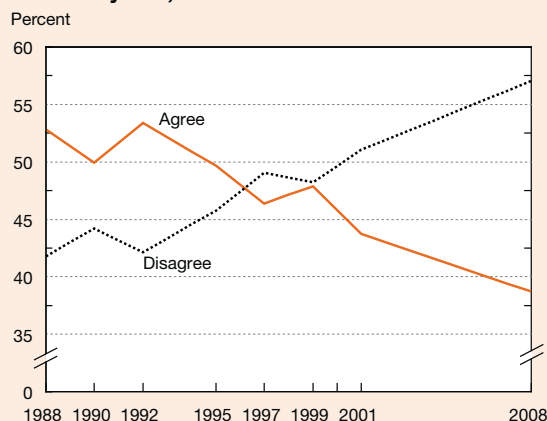


NOTES: Top panel: survey results in 1985, 1988, 1990, 1992, 1995, 1997, 1999, 2001, and 2008; other years extrapolated. Bottom panel: survey results in 1981, 1983, 1985, 1988, 1990, 1992, 1997, 1999, 2001, 2002, 2004, 2006, and 2008; other years extrapolated.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (years through 2001); and University of Chicago, National Opinion Research Center, General Social Survey (2008 in top panel, 2002–08 in bottom panel). See appendix table 7-30 for top panel and appendix table 7-23 for bottom panel.

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**Figure 7-21**  
**Public attitudes toward conducting human health research that may inflict pain or injury to animals:**  
**Selected years, 1988–2008**



NOTES: Responses to *Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems*. Table includes all years for which data collected. Survey results from 1988, 1990, 1992, 1995, 1997, 1999, 2001, 2008; other years extrapolated.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Public Attitudes Toward and Understanding of Science and Technology (1988–2001); and University of Chicago, National Opinion Research Center, General Social Survey (2008).

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## Conclusion

In assessing public knowledge and attitudes concerning S&T, two kinds of standards for judgment are possible. One standard involves comparing a country's knowledge and attitudes with those recorded in the past or in other countries. The second standard involves assessing what a technologically advanced society requires (either today or in the future) to compete in the world economy and enable its citizens to better take advantage of scientific progress in their own lives.

By the first standard, the survey data provide little or no evidence of declining knowledge or increasingly negative attitudes. Relative to Americans in the recent past, today's Americans score as well on knowledge measures and tend to be more skeptical about scientific claims for pseudoscience, such as astrology. In addition, three decades of U.S. data consistently show that Americans endorse the past achievements and future promise of S&T, are optimistic about new technologies, and are favorably predisposed to increasing government investment in science. When Americans compare science with other institutions, science's relative ranking is as or more favorable than in the past. In addition, the prestige of the engineering profession grew in the last year.

When the data are examined using other countries as a benchmark, the United States compares favorably. Compared with adult residents of other developed countries, Americans appear to know as much or more about science, and they express as much or more optimism about technology.

By the second standard, trend data show that significant minorities of Americans cannot answer relatively simple knowledge questions about S&T; they express basic misconceptions about emerging technologies such as biotechnology and nanotechnology, and they believe that relatively great scientific uncertainty surrounds the existence and causes of global climate change. Sizable parts of the population express reservations about how the speed of technological change affects our way of life or the use of animals in medical research.

Regardless of the standard used in assessing public knowledge and attitudes, one pattern in the data stands out: more highly educated Americans tend to know more about S&T, express more favorable attitudes about S&T, and make discriminations that are more consistent with those likely to be made by scientists and engineers themselves. Thus, for example, they focus more heavily on process criteria when evaluating whether something is scientific, and their classification of fields as more and less scientific more closely resembles a classification that would be found in a university catalog. Whether this association is causal is uncertain. Although greater knowledge may affect attitudes and perspectives, pre-existing attitudes and perspectives may affect whether or not people acquire the kinds of knowledge available to them in school.

## Notes

1. Data from Pew show that the proportion of Americans who read the newspaper declined from 40% to 34% between 2006 and 2008 and that newspapers would have lost more readers if they did not have online versions. Most of the loss in newspaper readership since 2006 has come from those who read the print version of the newspaper—in 2008, 27% said they had read only the print version of a daily newspaper the day before compared to 34% in 2006 (Pew Research Center for the People and the Press 2008).

2. In 2001 this question was part of a single-purpose telephone survey focused on science and technology. In 2008 these data were collected as part of a face-to face multi-purpose survey covering a broad range of behavior and attitudes. It is unclear whether these differences in data collection or a change in public opinion account for the decline in interest observed between 2001 and 2008. In interviews conducted over the phone, respondents may be more likely to respond to questions in a socially desirable way (Holbrook, Green, and Krosnick 2003). In addition, a single purpose survey may suggest to respondents that science and technology are important.

3. In interpreting survey data that use the phrase “science and technology,” it is important to take into account the uncertainties surrounding its meaning and the different associations Americans make when they hear it.

4. The peak in the coverage of the category “Science, space, and technology” in 1999 illustrated in figure 7-6 includes major network coverage of stories about the so-called millennium bug and business issues from the dot.com boom such as the rise of Internet commerce and the browser antitrust wars.

5. The question on interest in new scientific discoveries included in the 2005 Eurobarometer (EC 2005) was the same three-category question asked in the United States between 1979 and 2001 and in 2008 (“very interested,” “moderately interested,” and “not at all interested”). The question asked in the 2007 Eurobarometer (EC 2007) was different because it asked about interest in “scientific research” rather than “new scientific discoveries” and gave respondents four options (“very interested,” “fairly interested,” “not very interested,” and “not at all interested”). Thus, the data in this sidebar are not strictly comparable to earlier Eurobarometer surveys or to the U.S. data question on interest.

6. In Brazil the survey asked respondents about their interest in “medicine and health” issues and “environmental issues” and the question categories included “very interested,” “a little interested,” and “not at all interested.”

7. In the past, interest in space exploration has consistently ranked low both in the United States and around the world, relative to other S&T topics. Surveys in Russia, China, and Japan have documented this general pattern. However, though there are new U.S. data on this subject, there have been no recent surveys documenting interest in space exploration in other countries.

8. People can become involved with S&T through many other nonclassroom activities. Examples of such activities

include participating in government policy processes, going to movies that feature S&T, bird-watching, and building computers. Nationally representative data on this sort of involvement with S&T are unavailable.

9. In the 2008 GSS, respondents received two similar introductions to this question. Response patterns did not vary depending on which introduction was given.

10. Survey items that test factual knowledge sometimes use easily comprehensible language at the cost of scientific precision. This may prompt some highly knowledgeable respondents to feel that the items blur or neglect important distinctions, and in a few cases may lead respondents to answer questions incorrectly. In addition, the items do not reflect the ways that established scientific knowledge evolves as scientists accumulate new evidence. Although the text of the factual knowledge questions may suggest a fixed body of knowledge, it is more accurate to see scientists as making continual, often subtle, modifications in how they understand existing data in light of new evidence.

11. Formal schooling and verbal skills are positively associated. In the 2008 GSS data, verbal skills contributed to factual knowledge even when controlling for education.

12. Among respondents with comparable formal education, attending informal science institutions was associated with greater knowledge.

13. The two nanotechnology questions were asked only of respondents who said they had some familiarity with nanotechnology, and a sizable majority of the respondents who ventured a response different from “don’t know” answered the questions correctly. To measure nanotechnology knowledge more reliably, researchers would prefer a scale with more than two questions.

14. The questions were selected from the Trends in Mathematics and Science Studies (TIMSS), National Assessment of Educational Progress (NAEP), practice General Educational Development (GED) exams, and AAAS Project 2061.

15. The scoring of the open-ended questions closely followed the scoring of the corresponding test administered to middle-school students.

For the NAEP question “Lightning and thunder happen at the same time, but you see the lightning before you hear the thunder. Explain why this is so,” the question was scored as follows:

- ♦ **Complete:** The response provided a correct explanation including the relative speeds at which light and sound travel. For example, “Sound travels much slower than light so you see the light sooner at a distance.”
- ♦ **Partial:** The response addressed speed and used terminology such as thunder for sound and lightning for light, or made a general statement about speed but did not indicate which is faster. For example, “One goes at the speed of light and the other at the speed of sound.”
- ♦ **Unsatisfactory/Incorrect:** Any response that did not relate or mention the faster speed of light or its equivalent, the

slower speed of sound. For example: “Because the storm was further out.” or “Because of static electricity.”

For the TIMSS question “A solution of hydrochloric acid (HCl) in water will turn blue litmus paper red. A solution of the base sodium hydroxide (NaOH) in water will turn red litmus paper blue. If the acid and base solutions are mixed in the right proportion, the resulting solution will cause neither red nor blue litmus paper to change color. Explain why the litmus paper does not change color in the mixed solution,” the question was scored as follows:

- ♦ **Correct:** The response had to refer to a neutralization or a chemical reaction that results in products that do not react with litmus paper. Three kinds of answers were classified as correct:
  - The response referred explicitly to the formation of water (and salt) from the neutralization reaction (e.g., “Hydrochloric acid and sodium hydroxide will mix together to form water and salt, which is neutral.”)
  - The response referred to neutralization (or the equivalent) even if the specific reaction is not mentioned (e.g., “The mixed solution is neutral, so litmus paper does not react.”)
  - The response referred to a chemical reaction taking place (implicitly or explicitly) to form products that do not react with litmus paper (or a similar substance), even if neutralization was not explicitly mentioned (e.g., “The acid and base react, and the new chemicals do not react with litmus paper.”)
- ♦ **Partially correct:** The response mentioned only that acids and bases are “balanced,” “opposites,” “cancel each other out,” or only that it changes to a salt without mentioning the neutralization reaction. These answers suggest that the respondent remembered the concept but the terminology they used was less precise, or that the answer was partial. For example, “they balance each other out.”
- ♦ **Incorrect:** The response did not mention any of the above or is too partial or incomplete, and/or uses terminology that is too imprecise. For example, “Because they are base solutions—the two bases mixed together there is no reaction.” or “There is no change. Both colors change to the other.”

16. In its own international comparison of scientific literacy, Japan ranked itself 10th among the 14 countries it evaluated (National Institute of Science and Technology Policy 2002).

17. Early NSF surveys used additional questions to measure understanding of probability. Through a process similar to that described in note 12, Bann and Schwerin (2004) identified a smaller number of questions that could be administered to develop a comparable indicator. These questions were administered in 2004 and 2006, and appendix tables 7-13 and 7-14 record combined probability responses using these questions; appendix table 7-13 also shows responses to individual probability questions in each year.

18. Figure 7-12 includes four questions on experimental design included in appendix tables 7-13 and 7-15. Two of these four questions include a question on experimental design and a follow-up question asking “why”; correct responses to these two questions represent the combined responses and are incorporated into the figure as one question.

19. The pseudoscience section focuses on astrology because of the availability of long-term national trend indicators on this subject. Other examples of pseudoscience include the belief in lucky numbers, the existence of unidentified flying objects (UFOs), extrasensory perception (ESP), or magnetic therapy.

20. Methodological issues make fine-grained comparisons of data from different survey years suspect. For instance, although the question content and interviewer instructions were identical in 2004 and 2006, the percentage of respondents who volunteered “about equal” (an answer not among the choices given) was substantially different. This difference may have been produced by the change from telephone interviews in 2004 to in-person interviews in 2006 (though telephone interviews in 2001 produced results that are similar to those in 2006). More likely, customary interviewing practices in the three different organizations that administered the surveys affected their interviewers’ willingness to accept responses other than those that were specifically offered on the interview form, including “don’t know” responses.

21. There are large differences among European countries. The lowest support for this statement is found in Iceland, with 38% expressing agreement. Other countries where less than half of residents agree include Ireland (42%), Finland (44%), Denmark (44%), the United Kingdom (45%), and the Netherlands (47%).

22. This type of survey question asks respondents about their assessment of government spending in several areas without mentioning the possible negative consequences of spending (e.g., higher taxes, less money available for higher priority expenditures). A question that focused respondents’ attention on such consequences might yield response patterns less sympathetic to greater government funding.

23. Unlike the U.S. question, the European question joins two logically independent ideas—more spending on science and less spending on other priorities. In addition, because nations begin from different levels of spending, survey responses cannot be read as indicating different views about the proper level of spending in this area, nor do they indicate the strength of sentiment in different countries. Differences in the connotations of questions posed in different languages add further complexities. Perhaps for some or all of these reasons, variations among European countries in responses to this question are large, with about two-thirds of respondents agreeing in Italy, Spain, and France, but less than one-third in Finland and the Netherlands.

24. There are many different types of specializations within occupations and prestige may well vary within the same occupation or industry.

25. The two questions from the 2009 Gallup survey were each asked to half the sample (N=500).

26. Countries with nuclear plants include Belgium, Bulgaria, the Czech Republic, Finland, France, Germany, Hungary, Lithuania, the Netherlands, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Two exceptions to this pattern are Romania and Spain, both of which have operational nuclear power plants but where the level of support for nuclear energy is below the EU-27 average. An earlier Eurobarometer study showed that the Spaniards and the Romanians were less aware of the fact that their countries have nuclear power plants than respondents in other countries with nuclear plants in operation. This low level of awareness regarding the operation of a nuclear plant in their country may lead to a less positive attitude about nuclear energy.

27. A 2006 Canadian survey showed little or no change from 2005 (Decima Research 2006).

28. According to a recent report from The National Academies, more than 600 products involving nanotechnology are already on the market; most of them are health and fitness products such as skin care products and cosmetics (The National Academies, 2008a).

29. The increase in the proportion of respondents who disagree with this statement may be related to methodological issues, because of the changes in data collection discussed above.

## Glossary

**Biotechnology:** The use of living things to make products.

**Climate change:** Any distinct change in measures of climate lasting for a long period of time. Climate change means major changes in temperature, rainfall, snow, or wind patterns lasting for decades or longer. Climate change may result from natural factors or human activities.

**EU-15:** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

**EU-25:** Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

**EU-27:** Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

**Genetically modified food:** A food product containing some quantity of any genetically modified organism as an ingredient.

**Global warming:** An average increase in temperatures near the Earth’s surface and in the lowest layer of the atmosphere. Increases in temperatures in the Earth’s atmosphere can contribute to changes in global climate patterns. Global

warming can be considered part of climate change along with changes in precipitation, sea level, etc.

**Nanotechnology:** Manipulating matter at unprecedentedly small scales to create new or improved products that can be used in a wide variety of ways.

**Reproductive cloning:** Technology used to generate genetically identical individuals with the same nuclear DNA as another individual.

**Therapeutic cloning:** Use of cloning technology in medical research to develop new treatments for diseases; differentiated from human reproductive cloning.

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